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Popular Science

The What's New magazine

Secrets of a GOOD WOOD STOVE

Energy from OCEAN WAVES

WIND POWER for home heating

PS editor flies the new STOL's

SPECIAL ELECTRONICS SECTION

- New video-cassette recorders
- Buyer's guide to turntables
- Plug-in versatility for your home computer
- New digital tuners
- Super-size TV pictures from kits

NEW ELLIPTIC TIRE stretches your gas mileage

ENERGY SAVERS: Winter warm room • Fireplace accessories • Soffit covers

The Buick Wagons. Built in the belief that if all you wanted was cargo space, you'd buy a truck.

A slight overstatement, true. But if all you ask of a wagon is mere hauling ability, perhaps you're not asking enough.

In which case, let us direct your attention to the new Buick Century Wagon or its slightly larger cousin, the Buick Estate Wagon.

Can they haul? The answer is a resounding *yes*. With nearly 72 cubic feet of cargo space in the Century, and 87 in the Estate Wagon.

But that isn't what makes a Buick Wagon special. It isn't that a Buick can haul as much as a truck. But rather the serene way it goes about its chores. *That's* the difference.

The ride is smooth and unruffled. (Buick's computer-tuned suspension helps out greatly here.)

And how comfortable it is. Upholstery-wise, there's a choice of available fabrics that ranges from rugged vinyl to supple velour in the Estate Wagon. And the decor is elegant enough to convince you you're riding in a fine automobile.

In motion the Century Wagon is a product of the times—trimmer, lighter on its feet, decidedly more nimble to handle in traffic than last year's counterpart. And because of that, less power is required to move it, too. In fact, the Century is powered by a new, even-firing, 231-cubic-inch, (3.8 litre), V-6, which in turn does marvelous things with a gallon of gas.

According to EPA estimates, a Century Wagon with standard 231-cubic-inch, (3.8 litre), V-6 and automatic transmission achieved 27 mpg in the highway test, and 19 mpg in the city test, for a combined figure of 22 mpg. (California estimates are lower.) Your mileage may vary depending on the condition of your car, its equipment, and your driving habits.

Incidentally, the V-6 isn't the only powerplant that's available in the Century, either. In fact, all Buick wagons are available with a selection of GM-built engines produced by various divisions. See your dealer for details.

And while you're there, be sure to test-drive the Buick Wagon of your choice.

There is a difference in wagons, believe us.

BUICK

A little science. A little magic.

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The Kodak Ektasound movie camera makes it so easy to take sound movies. Just drop in a cartridge of film, such as Kodak Ektachrome 160 sound movie film, and push the shutter release. It's that simple.

And the microphone? It's right on the handle! So, you're free to move around and shoot wherever you want without worrying about cords or microphone placement.

You don't need movie lights, either. Indoors or outdoors, in room light or sunlight, the Kodak Ektasound movie camera takes colorful sound movies without movie lights.

There's also an automatic exposure control that adjusts the amount of light reaching the film.

Kodak's unique on-camera microphone. Sound made simple.

And, there's a sound monitor so you can hear what the camera is hearing–both before and during use.

Ask your photo dealer for a demonstration. There are several models to choose from including the new model 250 with power zoom and the new model 260 with power zoom and coupled rangefinder.

Kodak Ektasound movie cameras

Kodak

NOVEMBER 1977
Founded in 1872/Vol. 211, No.5

Popular Science

MONTHLY®

The What's New magazine

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We're about to shatter an image.

This One

7L9L-P3T-B559

If you're one of those people who think that the sun rises and sets on Jeep, you've come to the right ad. It'll tell you that there just might be something better. Like an International Harvester Scout® II.

Big words, no doubt. But then, there are some big facts to back them.

Scout's axle ratings, for instance, are much higher than Jeep CJ-7's. 500 pounds more up front. 450 pounds more in back. Meaning Scout can really take a pounding.

Scout's got a two-foot tighter turning circle. An advantage that hardly needs elaboration.

Scout's got better seating capacity. Five big men can ride in comfort.

Scout's got a 20-inch longer cargo bed than CJ-7. Power front disc brakes instead of drums. A 19-gallon gas tank versus 15.5. And a removable steel roof instead of no roof at all (if you want one, Jeep makes you pay extra).

What's more, they're all differences that make a difference. A recent survey of 4-wheel drive vehicle owners showed that, on the measure of "very satisfied," Scout outscored Jeep by 25%.

So there you have it. Hard facts. And the opinion of people just like you.

Just goes to show that some images are more fragile than you think.

Scout® leads the way.

There's only so much an ad can tell you about this much machine. So we're offering you free brochures with full information telling how all Scouts lead the way. Check the one you're interested in and we'll get it to you, pronto.

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PS READERS TALK BACK

Address letters for this column to: Readers Talk Back, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

Caution on solar plumbing

Re the PS update on solar-heating equipment [Aug.]: Your readers should know that systems employing single-wall heat exchangers in contact with potable water supplies (such as the Revere Sun Pride pictured) may run afoul of local plumbing codes. Many codes specify that a double-wall exchanger must be used in any system having a toxic fluid (which glycol/water is) as a transfer medium. A fluid leak in a single-wall exchanger can contaminate the potable water supply with poisonous substances. Though a bit more elaborate and expensive (requiring a second pump), a system employing a double-wall exchanger eliminates this problem and is much preferred.

Frank J. LeGeros, Solar Resources Inc., Pawtucket, R.I.

Plywood contest

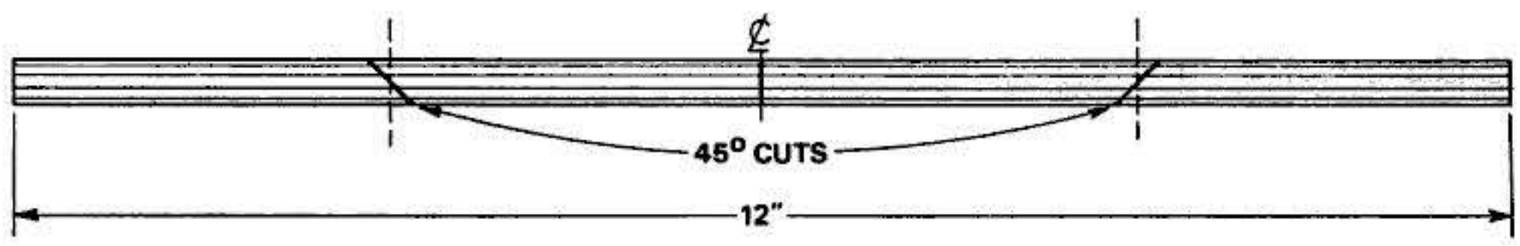
Just wanted to tell you how much I liked your plywood contest [Aug.]. [After reading the article] a friend and I made the sawbuck table. We were two relative novices with a rented jigsaw, a seamstress' measuring tape, and a borrowed T square. It took about four hours to get the table assembled (painting excluded).

There was only one mystery. The diagram [p. 109] shows the apron section as 3⅜" wide. How does one cut four 3⅜" pieces from one 12" section? We used 3" pieces and the table looks great. We've had many compliments.

Thanks again for a great magazine.

Judy Horton, Waltham, Mass.

Al Lees replies: "Here's how you cut those pieces. Because of what's lost to saw kerfs, you may be a little scant of the 3⅜ inches, but that dimension isn't critical. Rip all four strips (as shown below), then miter-cut to length."



Inches and R-values

I read with interest your article "Attic Cooling" by Evan Powell [Aug.]. At the bottom of page 64 you have a table from Owens-Corning Fiberglas showing the dollar savings in air-conditioning costs that can be achieved with attic insulation. You show inches along with R-values, which coincide as long as Owens-Corning batt or roll-type insulation is used. But this table would be very confusing to the general public if they now have or are considering installing fiberglass blowing wool. Different R-values along with inches installed apply if blowing wool is used.

If Owens-Corning blowing wool is installed at the proper thickness, along with the correct number of bags per 1000 sq. ft., these R-values would be obtained (CertainTeed and Johns-Manville data are nearly identical):

R-value	Minimum thickness	Bags per 1000 sq. ft.
R-30	13¾"	30
R-22	10"	22
R-19	8¾"	20
R-11	5"	11

If rock wool or slag wool is installed, a higher R-value is obtained with a reduced amount of insulation, with both batts and blowing wool. If R-values alone were shown in your article, without inches, no confusion would exist.

William L. Bricka, Nashville, Tenn.

Insulation answers

In the September article, "Insulation Upgrade," Al Lees omitted some information that would have been helpful. For instance, Lees says, "Never float a vapor barrier *between* insulation layers." Now I know why: It presumably traps moisture. But what to do? Remove the barrier? Punch holes in it? There isn't a

Continued

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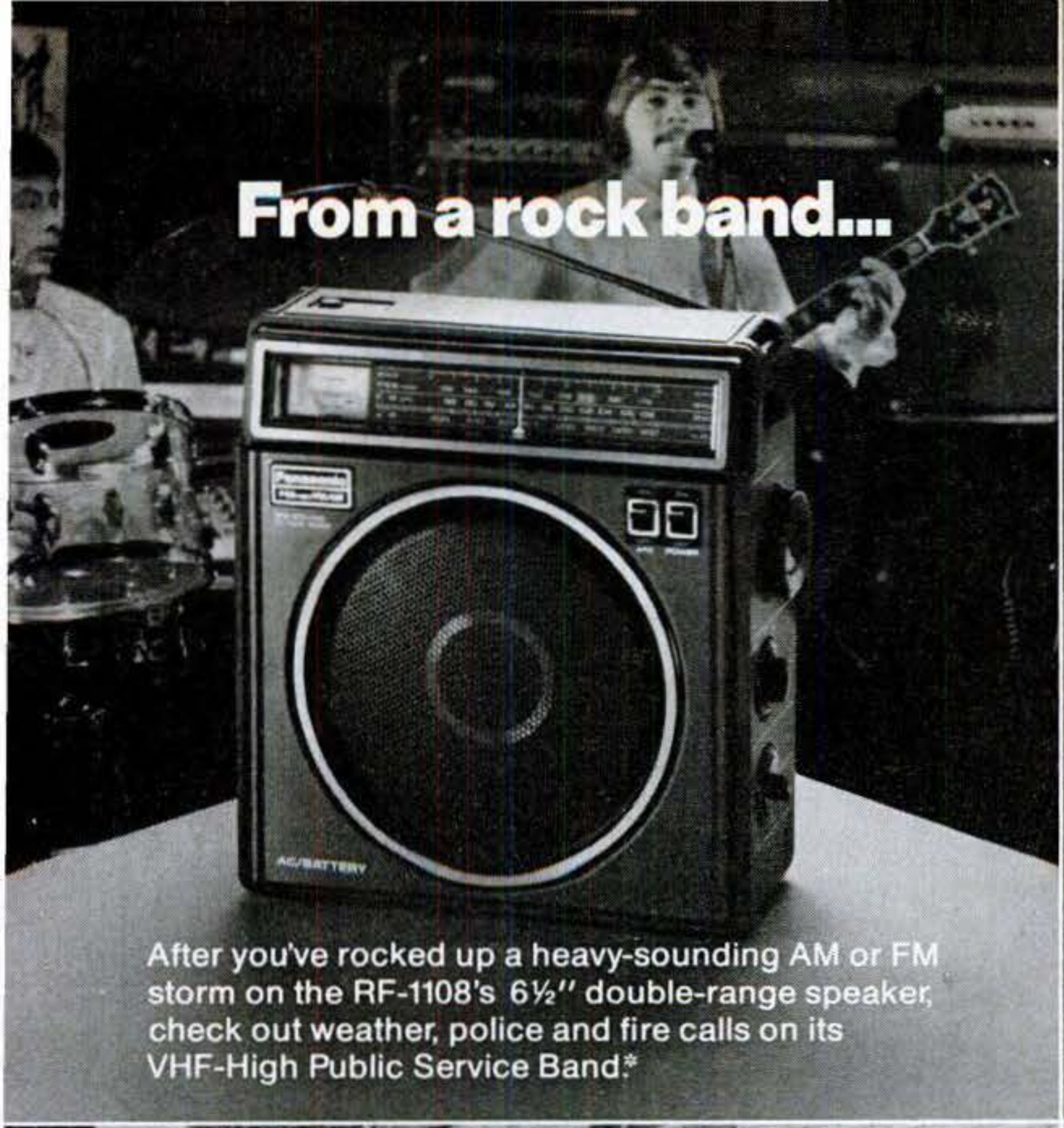
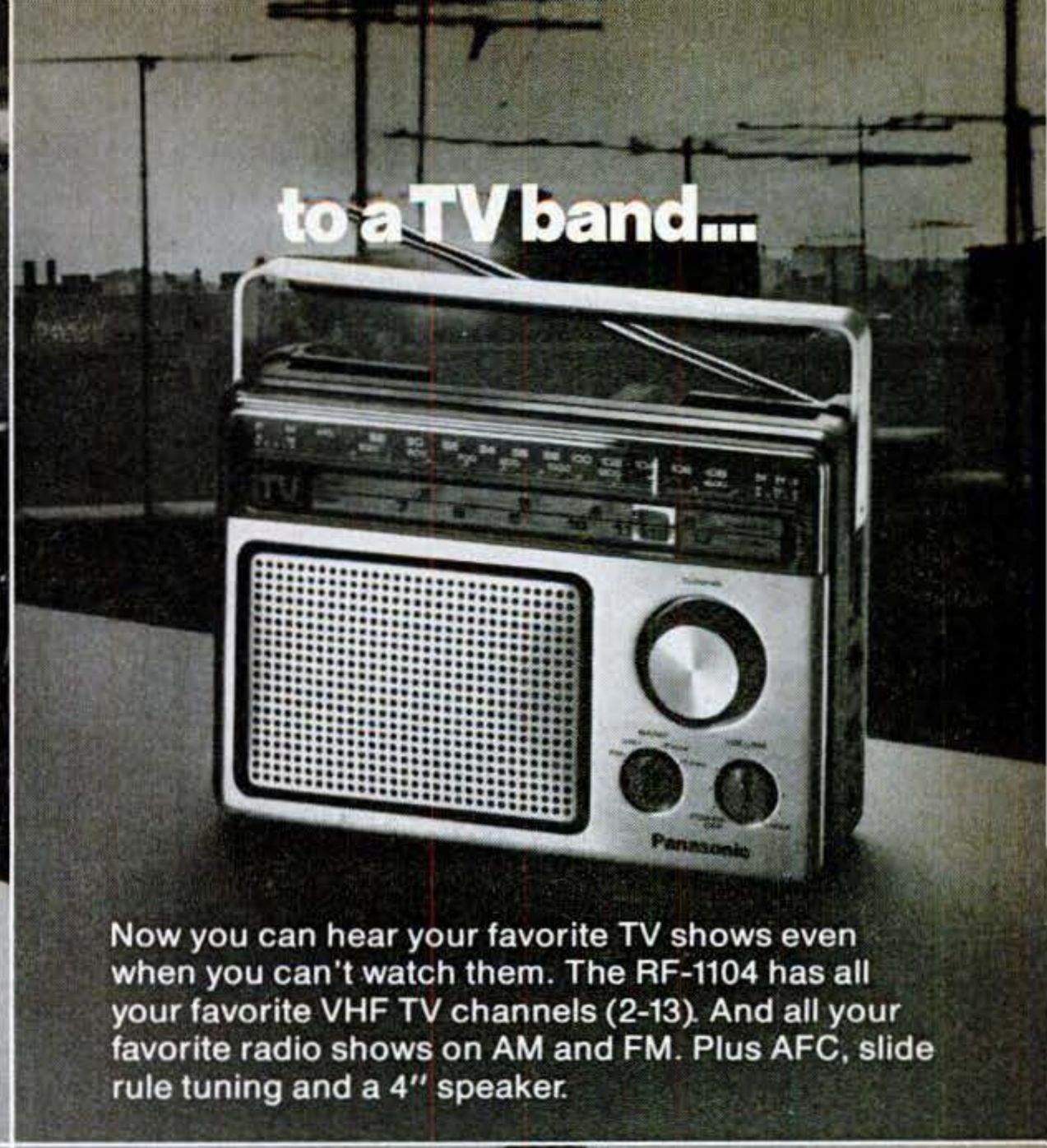
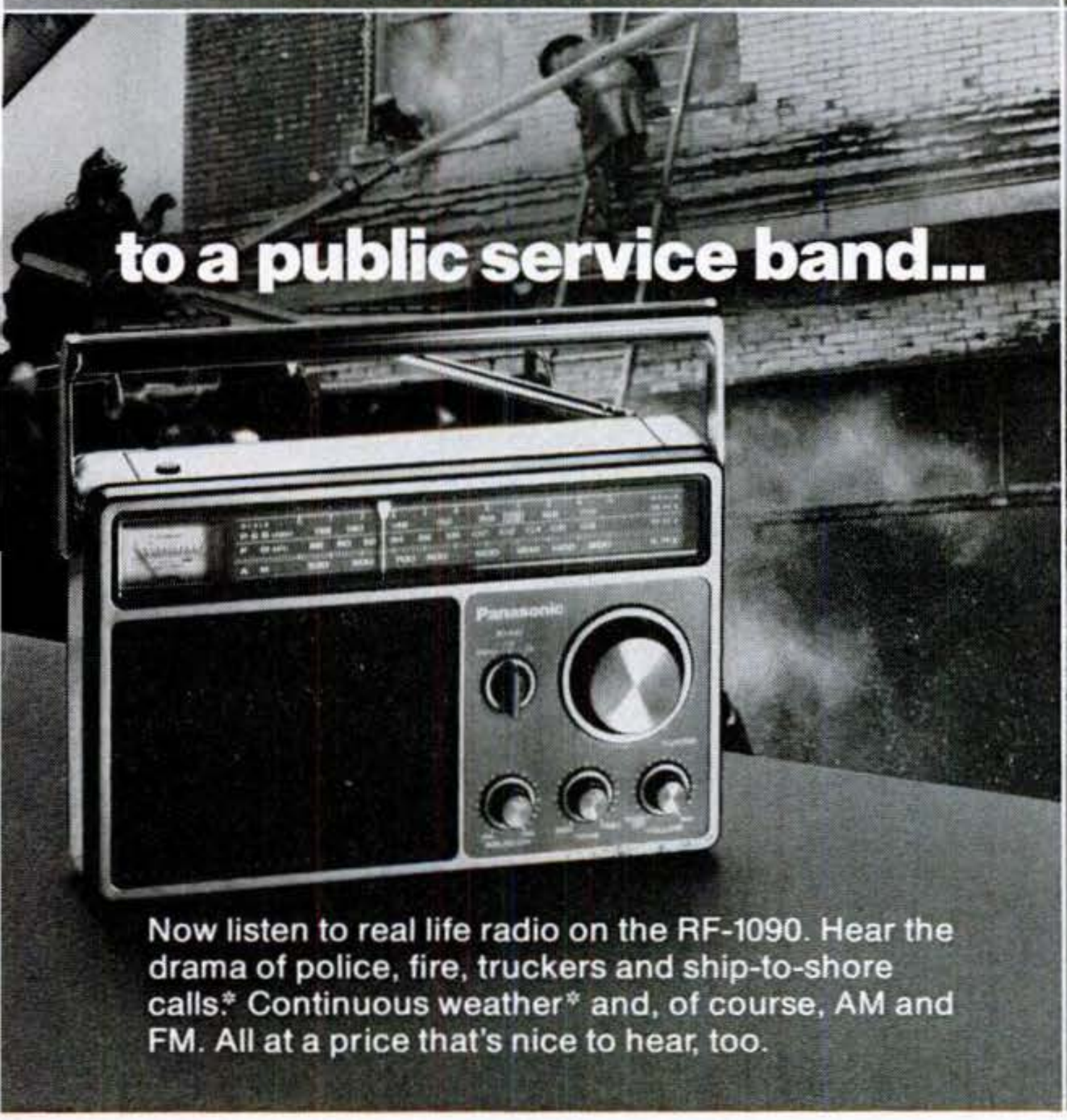


After you've rocked up a heavy-sounding AM or FM storm on the RF-1108's 6½" double-range speaker, check out weather, police and fire calls on its VHF-High Public Service Band.*



Now you can hear your favorite TV shows even when you can't watch them. The RF-1104 has all your favorite VHF TV channels (2-13). And all your favorite radio shows on AM and FM. Plus AFC, slide rule tuning and a 4" speaker.



Now listen to real life radio on the RF-1090. Hear the drama of police, fire, truckers and ship-to-shore calls.* Continuous weather* and, of course, AM and FM. All at a price that's nice to hear, too.

Listen to across-the-ocean sounds and across-the-street sounds with the RF-2200. Six short wave bands and AM and FM. Plus fast/slow selector for accurate tuning. And features you'd find in higher-priced radios.

Introducing the new Tech Series from Panasonic. There's more to our radios than AM/FM.

A lot more. Like CB, TV, short wave or PSB. In all, 8 different Tech Series radios. And all combine rugged good looks with sound so good, it's hard to believe it comes from a portable. And so many extras like Panasonic batteries and earphone, you'll wonder how we managed to squeeze in the AM and the FM.

*Public service broadcasts vary by area. Check with local authorities.

Tech series

Panasonic.

just slightly ahead of our time.

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Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.
18 mg. "tar." 1.1 mg. nicotine av. per cigarette, FTC Report Dec.'76

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Country.
FILTER CIGARETTES
Marlboro
20 CLASS A CIGARETTES
100's
FILTER CIGARETTES
Marlboro
100's
CLASS A CIGARETTES
Marlboro Red or Longhorn 100's—
you get a lot to like.

Computer Scale

Add some fun to losing weight with a new, extremely accurate and easy-to-read digital scale.

It's fun to weigh yourself on a computer. Just step on the Counselor computer scale and your exact weight in pounds is flashed on the display in bright red numbers.

Losing weight is not easy. Ask anyone.

One of the few pleasures of losing weight is stepping on your bathroom scale and seeing positive results. Your bathroom scale is like a report card—a feedback mechanism that tells you how well you've done.

The new American-made Counselor 77 platform scale is the newest and best way to weigh yourself. In the first place, it's accurate to within one pound. (Most platform scales are accurate to within three pounds.) Secondly, it has an easy-to-read, large LED (light-emitting diode) display. There are no balance beams or fine lines to interpret. And finally, it is easy to use—just step on it and read your weight. There's no guessing as your weight, up to 300 pounds, is flashed on the display.

EASY TO USE

Simply tap the activator bar in front of your scale with your toe and the unit turns on. Step on the scale, and read your weight. Fifteen seconds later, the scale shuts off automatically. The accuracy is not affected by temperature nor humidity like other scales since the Counselor 77 spring is precalibrated and sealed at the factory.

SEE THE DIFFERENCE

The best way to see the difference a really good scale makes in your weight reduction program is to try a Counselor scale for one month. We give you that opportunity with our free 30 day trial period. Weigh yourself every day. See how easy it is to read your exact weight loss on a daily basis. Soon, stepping on your scale becomes a fun experience for your whole family, and everybody starts watching his or her weight.

Service should never be required (other than yearly battery replacement) but JS&A's prompt service-by-mail facility is always ready to handle any service requirements. The Bearly Company, manufacturers of the Counselor, is the largest manufacturer of bathroom scales in the United States. JS&A is America's largest single source of space-age products, further assurance that your modest investment is well protected.

You can order your platform computer scale by sending your check for $49.95 plus $2.50 for postage and handling to the address below, or credit card buyers may call our toll-free number. Illinois residents should also add 5% sales tax.

By return mail, you'll receive your scale, four pen-light batteries, and your 90-day limited warranty. If you do not find that the Counselor scale is the best way to weigh yourself—far better than any scale you presently have in your home—then return it within thirty days for a prompt and courteous refund which will include your $2.50 postage. You can't lose, even if you just try the scale.

The age of weighing yourself by computer is here now. See how much fun losing weight can be with your own solid-state digital scale. Order one at no obligation today.

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PS readers talk back

[*Continued*]

square foot of unfaced fiberglass in the Roanoke Valley. In my case, I have six inches of loose rock wool between the second-floor ceiling joists of my 25-year-old house. I have bought 1800 sq. ft. of Kraft-paper-backed 3½-inch fiberglass insulation to lay over it, thereby increasing the R-value to approximately 30. So now what do I do? Please ask Lees to provide some answer. Also, while he is at it, suppiy some safety advice such as type of clothing, hand and eye protection, and the best way to cut fiberglass.

R. C. Herrenkohl, Roanoke, Va.

Al Lees replies: "Reader Herrenkohl asks for a short course in applying insulation, which wasn't the focus of my article. But here, briefly, are his answers: Since he's already got fiberglass with *a vapor barrier (and says they don't sell unfaced batts or rolls in Roanoke—an unusual situation since leading insulation manufacturers all include such a product in their lines), he must destroy its effectiveness by repeatedly slashing it with a utility knife before he lays it down atop the rock wool. To cut fiberglass, any household shear is fine. Some installers cut the batt across with a utility knife first, then follow with the shears through the fiberglass.*

"As for proper attire: Just don't wear short sleeves or shorts (fiberglass can irritate exposed skin). The plain cotton work gloves shown in our sketches are adequate hand protection. Keep all clothing separate from the rest of the next wash-day load. If you have any respiratory problem, wear a filter mask."

More oil-testing labs

In the recent excellent article concerning spectroscopic analysis of motor oils, several laboratories were listed that provide this type of technical service. Since we are one of the key labs in the Northeast offering this service, I believe that we should be included in any such list.

Jerome P. Sava, vice-president,
Metropolitan Petroleum Petrochemicals Co., Foot of East 22nd Street,
Bayonne, N.J. 07002

PS heard from two other labs that do oil analysis: Hauser Laboratories, 5680 Central Ave., P.O. Box G, Boulder, Colo. 80306; and Case Existological Laboratories Ltd., 783 Cave St., Victoria, B.C., Canada V9A 5T6.

Capstan-drive recorders

We regret that through inadvertence the color bands indicating capstan drive were left off the table of our October article, "The New Sound of Shirt-Pocket Tape Recorders." The capstan-drive models are: Courterport RAD7, Grundig 2010, Grundig 2050, Lanier Microsette 60, Panasonic RQ 170S, Pearlcorder SD, Sankyo MTC 10, Sony M-101.

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Realizing your next car should be a truck.

There you were, strolling along just minding your business, when all of a sudden there it was; all big and red and tough and shiny, practically cooing to you from the showroom floor. Buy a truck?—*you?* Oh well, it can't hurt to look, can it? So in you go.

What you discover first, of course, is how civilized a GMC is. Glory be, this seating's comfortable. And look at all the goodies you can order: available power steering, automatic transmission, air conditioning, stereo, cruise control. Gosh, the instrument panel's as nice as you'd find in a car. And hey—vent windows!

A test-drive? Oh, you couldn't...but then again, what's life without a little adventure, anyway? Besides, anything with such a good view of the road is bound to be a ball to drive, right? Well, okay...but just around the block.

Boy, sure is smooth up here. And all that cargo space—just imagine the stuff a guy could haul back there. *Buy* it? Oh, you couldn't...could you?

Come to think of it, *sure* you could.

RECREATION ROUNDUP

By HERBERT SHULDINER

RV makers strive for more mpg

Stung by mounting attacks on the gas-guzzling qualities of motorized campers, many RV manufacturers are stepping up their efforts to increase fuel efficiency—although slowly.

In previewing the '78 RV's recently, I observed no breakthroughs in this respect. In fact, there will hardly be any difference in mpg performance between '77 and '78 models. But I look for increasing improvements starting with '79 models, available next fall.

Biggest effort will be to reduce weight in trailers and motor homes. The reason, according to Dick Cordill, a Starcraft engineer, is that towing tests indicate that aerodynamic shape is not a major factor in fuel economy. Weight is, he says. Another big reason for cutting trailer weights is that cars are getting smaller and can't handle big trailers as well as they used to.

Cordill says manufacturers will have to use higher-strength steels that weigh less. They will also have to remove some convenience items that add weight, and also reduce the size of water and holding tanks.

Foam-core plastics may be used in bathroom fixtures and in cabinets to further reduce weight, Cordill adds.

One warning, though: Lighter doesn't mean cheaper. So you can expect the new higher-mpg campers to cost as much as, or more than, present ones.

National Parks war on litter

A five-cent deposit is now required for all beverage bottles and cans sold in more than 200 National Park areas. Secretary of Interior Andrus says, "We expect this will greatly reduce the amount of litter found along park roads, campgrounds, picnic areas and even in backpack country of many parks, where litter has unfortunately been increasing during the past several years."

One extra benefit of the program may be the recovery of large numbers of bottles and cans for recycling. A test in Yosemite National Park, Calif., last year led to the recovery of 30 tons of aluminum, glass, and steel.

Watch out for flash floods

The National Weather Service has issued a warning about this oft-ignored hazard to campers and fishermen—especially in mountainous areas, or near streambeds, arroyos, or other drainage paths.

The NWS says preparedness is the key to survival in a flash flood. They urge outdoorsmen and campers to stay tuned to radio stations to monitor weather conditions. If your radio can't receive nearby stations, be on the alert for increased speed of river flows, or rapid rises in water levels. Be ready to move quickly if you observe these danger signs.

The NWS also says you shouldn't try to drive through moving water or flooded areas. If your vehicle is stalled by flooding, get out and try to reach higher ground quickly if you can. Don't waste time trying to move the stalled vehicle, because flood waters can rise suddenly and sweep it away.

Snowmobile safety gains

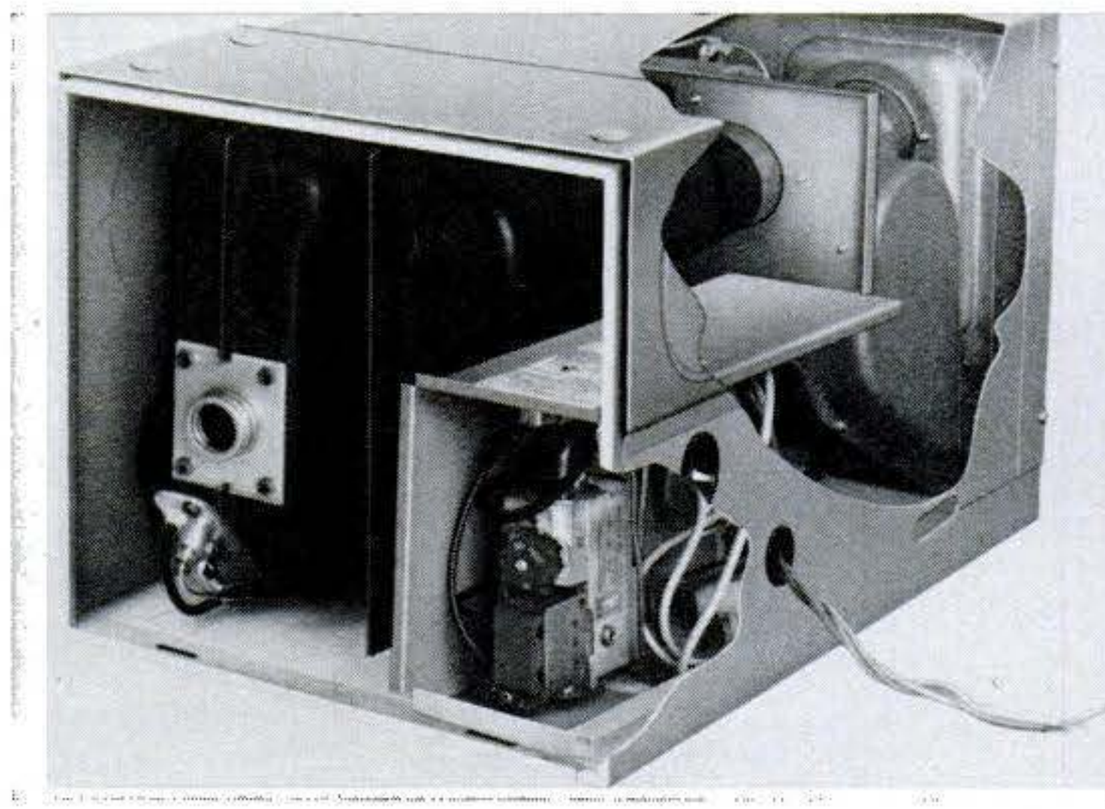
A 19-percent drop in snowmobile deaths last winter (despite an increase in the number of persons involved in the sport) indicates the safety record of these vehicles may be improving. Industry spokesmen say that better driver education and development of trails may be the reasons for the reduction in accidents and fatalities.

In the U.S., 98 people were killed last winter in accidents involving snowmobiles. Michigan, which had the most deaths (23), also had the most snowmobiles, with 382,000 registered.

Nearly one-third of the fatalities involved crashes with motor vehicles, both halted and moving, according to the NSC. Snowmobiles are supposed to be off-road vehicles, so if drivers stopped taking them on roads, fatal accidents could decline even more dramatically.

Sleek new van camper

Champion's new Trans-Van is no mere conversion. It's built on a cutaway chassis—the same kind that's used for mini motor homes. Wheelbase is 109 inches. The fiberglass body houses a commodious interior that seats up to 10 people and can sleep up to four. There's a rear galley with six feet, three inches of headroom. The Trans-Van comes with a 318-cu.-in. engine, or an optional 360-cu.-in. V8. It's also available with a four-wheel-drive package for off-road use. Made by Champion Home Builders Co., 5573 E. North St., Dryden, Mich. 48428, it's $8995 without 4WD, $12,600 with.



Safety furnace for recreational vehicles

A built-in purge cycle before ignition minimizes the risk of explosions in this new camper furnace made by Coleman. The furnace's electric spark igniter is automatically turned on, but not until the blower has been on for 15 seconds. This gets rid of any LP gas that might have accumulated while the furnace was off. The safety device has no pilot light, a fuel-saving bonus. The furnace comes in six models with a capacity range of 16,000 to 32,000 Btuh. Called the Presidential series, they're made by the Coleman Co., 250 N. St. Francis, Wichita, Kans. 67201.

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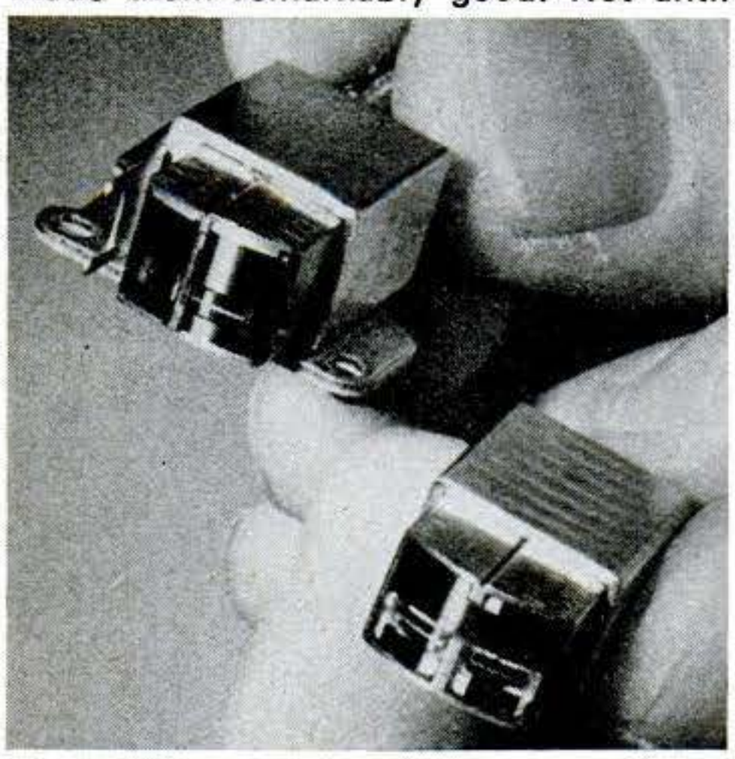
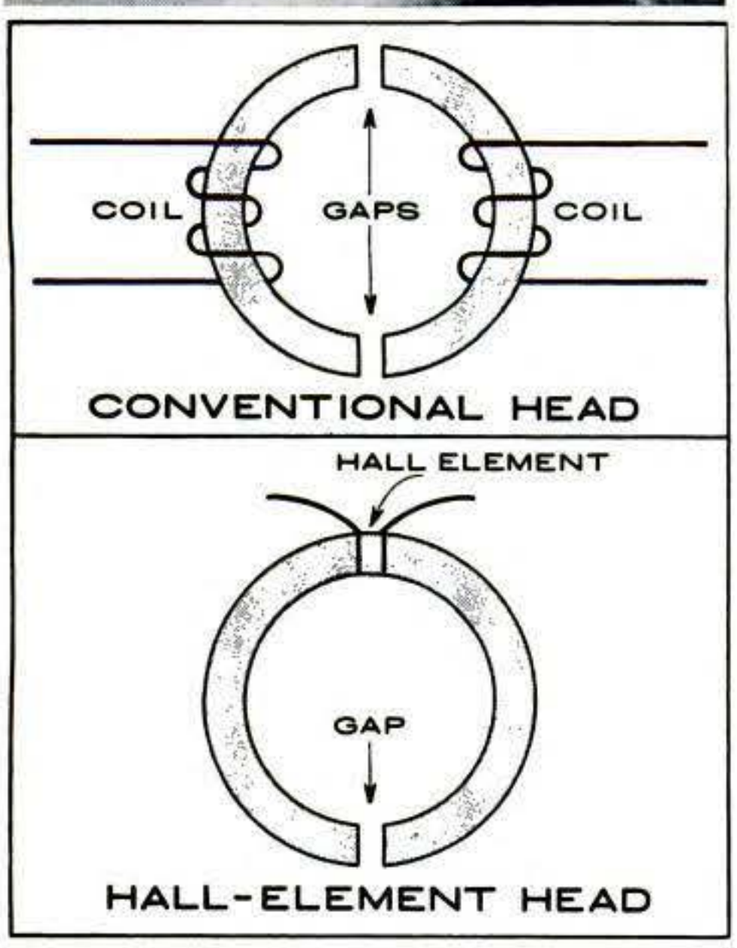
LOOK AND LISTEN

By WILLIAM J. HAWKINS

Hall-effect tape head

Tape recorders have undergone some dramatic advances in the past few years. Not only are they standardized, Dolbyized, and categorized into reel-to-reel, cassette, eight-track, and Elcassette, but sophisticated electronics has made them remarkably good. Not until





now, however, has the basic operating principle been changed.

Ordinarily, during playback, a piece of moving magnetic recording tape induces a tiny voltage in the coils of a conventional head. But with Hitachi's new Hall-effect head, that's no longer true.

The Hall-effect head uses regular recording tape, but the way it extracts the audio signals is entirely different. A Hall device has the unique property of being able to detect the effect of a magnetic field on a semiconductor material. Used as a head on a tape deck, it can detect the magnetic flux directly from the tape. The tape field is not used to produce a voltage in a coil as it is in a conventional head (see drawing). Equalization circuitry is no longer necessary. (It's required on standard heads because different frequencies, although of equal strength, will produce different signal amounts through a coil.) And the coilless system is limited only by the frequency response of the recording tape used. It gives a frequency response ranging from DC up to the gigahertz range, with no distortion from phase shifts at high frequencies, and with less electronics.

Another remarkable thing is that a Hall-effect system does not require the tape to be running to detect a magnetic field. With the tape stopped, the head will produce a DC voltage in proportion to the signal on the tape at that point. Imagine what that could mean for precision editing requirements!

Construction of the head is similar to that of a standard head (photo shows Hall effect on right, conventional head at left), but it allows many more tracks to be squeezed into the same area. This, along with its frequency response, makes it a new contender for video and digital recorders as well.

The Hall-effect technique is not new. It was discovered in 1880 by Edward Hall of Johns Hopkins University, but it served no useful purpose until the 1950's, when it was used in the laboratory to test the first transistors. More recently, it's been put to work in cars —as the integral sensor for many electronic ignition systems. As the playback head of a new Hitachi tape recorder, however, its fame has just begun. If this all sounds too good to be true, be assured that this doesn't solve all tape-recorder problems. The Hall-effect device can be used for playback only; we'll still have to deal with all of the usual recording problems, unfortunately.

Quick looks

- Magnetic fluid is the secret ingredient on some new speakers from AR and Advent. The tweeters, submerged in the stuff, are capable of handling higher wattages since heat and power peaks are quickly dissipated. Prices are between $95 and $450.
- Apparently German TV watchers take the tube much more seriously than we. The newest Blaupunkt TV can be programmed for up to a year's worth of watching—automatically turning itself on and tuning in the right channel at the right time.
- TI has developed the "ideal" TV set that meets the latest FCC goals for sensitivity and interference rejection. It means quality pictures on UHF channels and considerable immunity to CB interference. Price for the prototype: $200,000. But if designs are implemented on new sets, they will add only another $30 to the normal price.

A PS P.S.

Have you ever cleaned the face of your TV's picture tube with a spray cleaner and then wiped it dry? You shouldn't. A new booklet from the Electronic Industries Assn. advises you to use a cloth dampened with dishwashing detergent or home-laundry fabric softener, and let the surface air-dry. You'll get a better job and, more importantly, you won't be setting yourself up for a shock hazard.

And do you know that your TV antenna can build up a voltage if not properly grounded? It can. How do you ground it? That's in the booklet, too, and it's yours free if you send a stamped, self-addressed envelope to EIA Consumer Affairs, Box 19369, Washington, D.C. 20036.

Digital audio processor

Run any type of audio signal through this Rockwell International automatic digital audio processor (ADAP) and it removes most of the unwanted noise. Inside, the computer-based system makes a prediction of the incoming noise quantity based on the type of signal received. The computer-detected noise is removed and the resulting "clean" signal is sent out. While this method is used for recorded material, live sources can be dealt with another way. The unit has two inputs—one for the live signal with noise and another for just a sample of the noise. The system then subtracts the noise channel from the live one with a noise-free signal as the result. It costs $25,000. PS

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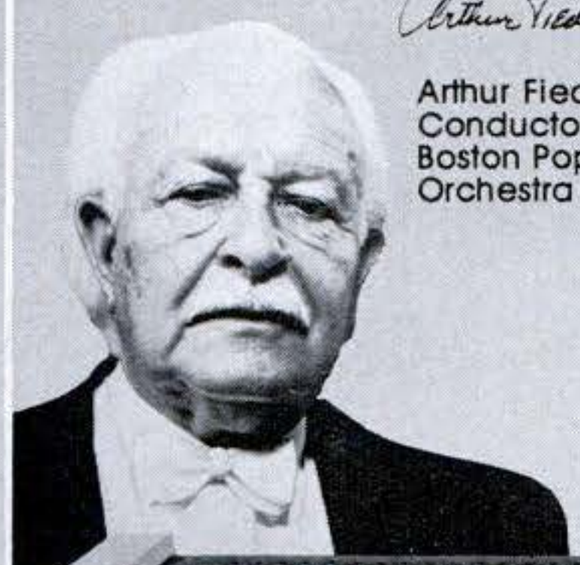
Arthur Fiedler



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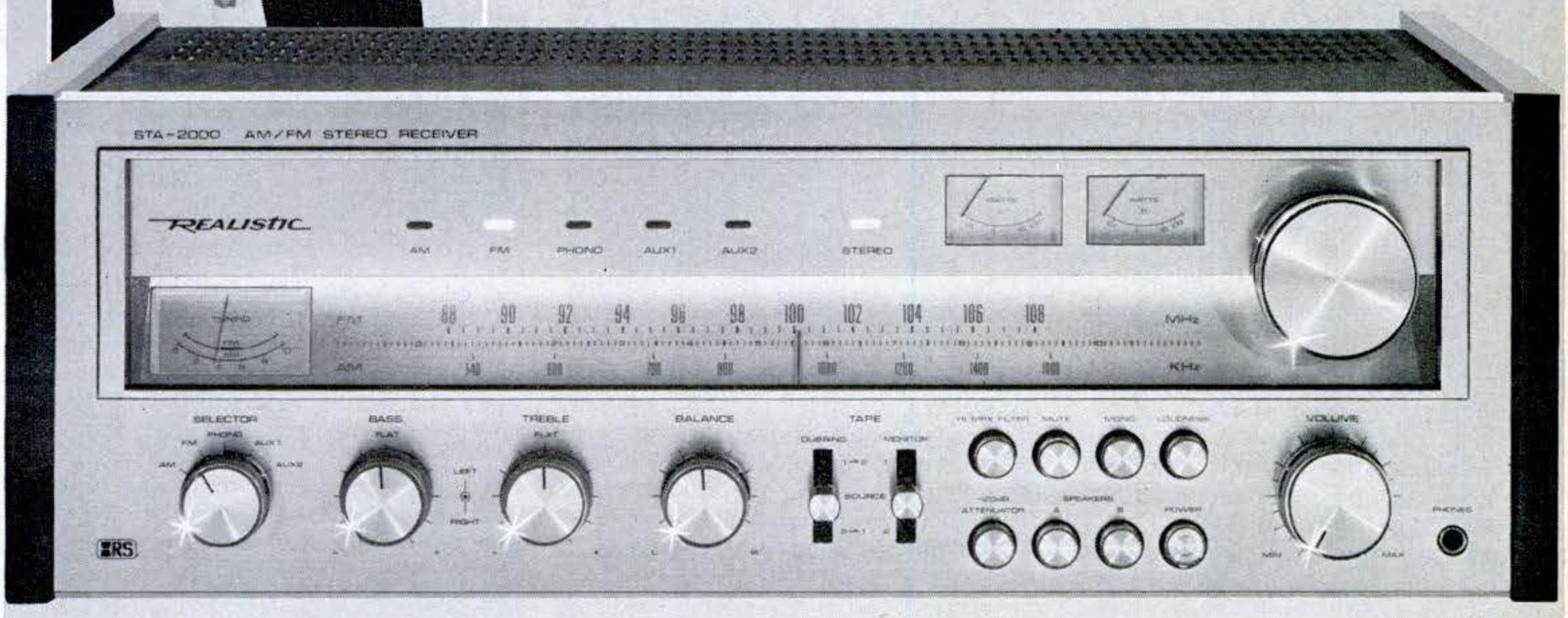

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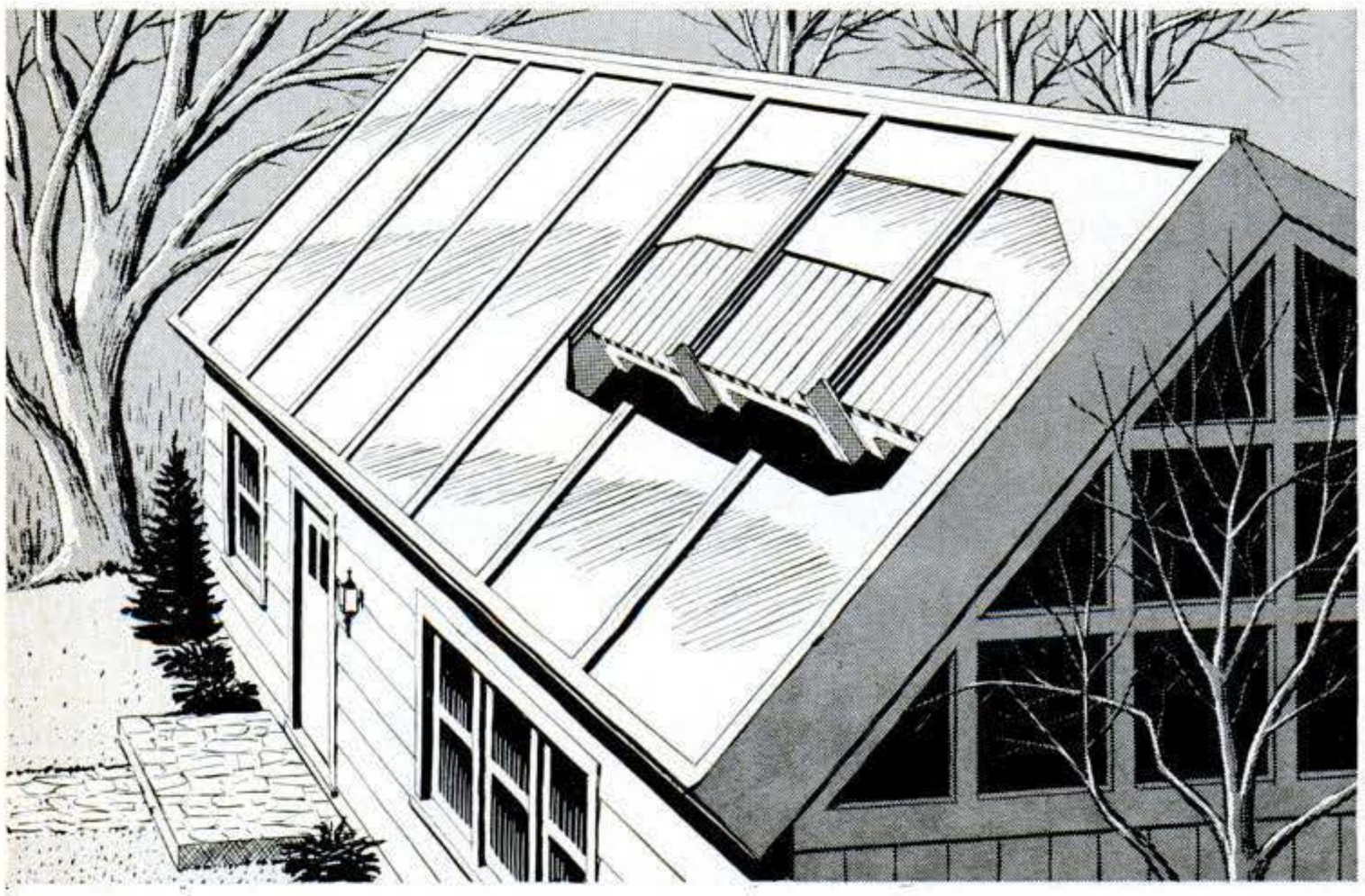
ILLUSTRATIONS BY RAY PIOCH



Structural roof panels collect solar heat

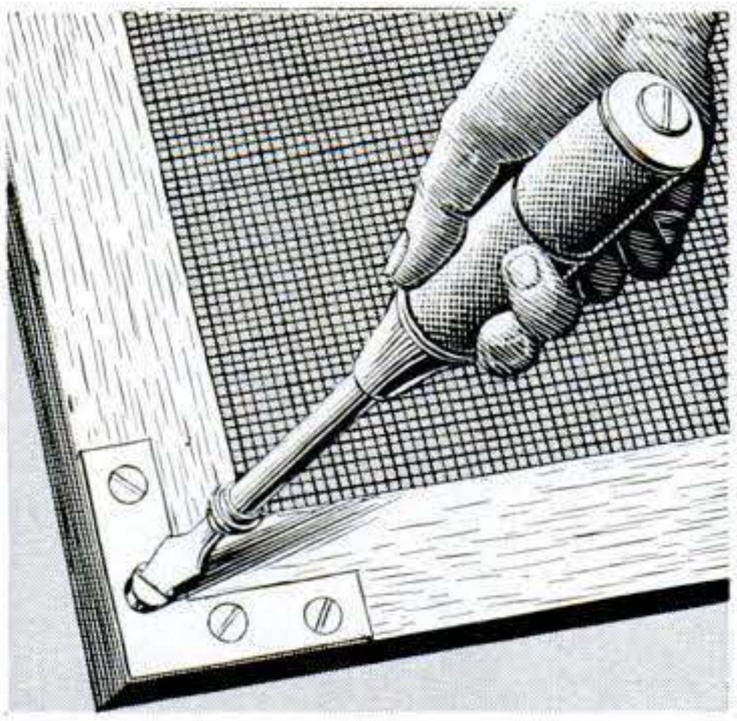
Solar heating has been slowed, according to this Energy Research and Development Administration patent, by the high cost and structural weakness of collection and storage materials. In this liquid-type system, two steel sheets would be rim-welded, expanded to form a network of passages, and bent at the edges so plates could be joined. Assembled with insulation below and glass above, the sturdy collector panels would double as integral parts of the roof structure.

Stand directs stereo sound

Adjustable to stand free behind any chair or sofa, this stereo loudspeaker system would separate left- and right-hand channels without the pressures and restrictions of headphones or fixed chair-back speakers, or the resonances that can occur in built-in enclosures. The rigid baffle and controlled angle and spacing of the speakers, it's claimed, improve sound quality and bass response.

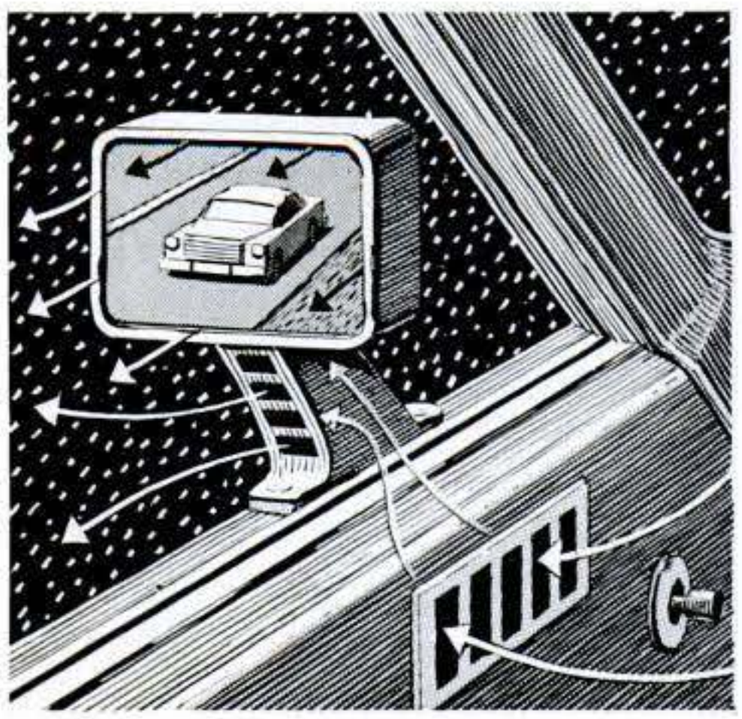
Canopy for weekend mechanic

You wouldn't have to put off planned free-time work on your car because of bad weather—or clear out your garage to do it—if you had a canvas or plastic fold-up canopy like this. Supported at the front by an adjustable pole and an angled bumper bracket, at the rear by a suction cup, it would keep you—and your engine—dry in rain or snow.



Handle clutches reverse driver

Fitted into separate knurled sleeves that form the handle of this screwdriver, two clutched drive cylinders would let you turn in either direction without shifting your hand or moving the chucked bit from a screw slot—like a ratchet driver, but without a button. Each handle half would engage in one direction, turn free in the other.



Duct de-ices side mirror

Ducted outside through slots in a car door or window, heated air from the passenger compartment would flow around and in front of this side mirror to melt snow or ice, de-fog the glass, prevent mist from clinging. Part of the air stream would be directed back at the window to help clear the windshield and improve a driver's view.

The following patents have been issued on these inventions: **Solar panels**—No. 4,010,733 to Stanley W. Moore, Los Alamos, N.M.; **Car canopy**—No. 3,870,061 to James I. Lowery, Houston, Miss.; **Screwdriver**—No. 3,868,983 to Dean R. Newcomb, Macedon, N.Y.; **Stereo speaker stand**—No. 3,870,834 to Ronald N. Yeaple, Fairport, N.Y.; **Automobile de-icing duct**—No. 3,859,899 to John E. Mills, Strongsville, Ohio.

Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

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Wave power tapped by nodding ducks

Scaled up from lab to reservoir to Loch Ness, they may soon head to sea

By DAVID SCOTT

The energy in a one-meter wave front off Great Britain's Atlantic coast could supply the electric-power needs of 12 homes. A one-kilometer front could deliver enough power for a town of 85,000. But how can this vast, clean, abundant energy be harnessed?

One promising answer, put forth by Andrew Salter, of Scotland's Edinburgh University, uses shaft-pivoted, cam-shaped floats to drive hydraulic pumps. They're called "nodding ducks" because of their birdlike profile and the way they bob in the waves [PS, May '75, p. 68].

Initially tested as a single duck module in a laboratory tank, Salter's design has been successfully scaled up to 30 watts of output in a reservoir trial, and a 20-kw model has just been launched in Loch Ness. With bigger tests now in the planning stage, the system could help alleviate Britain's energy crisis.

Salter made his breakthrough basically by matching his energy extractor to the actual motion of wind-swept water, which moves in circular orbits. At the surface, circle diameter equals wave height. With increasing depth, diameters shrink exponentially; lower circles overlap to outline the curved wedge shown at the left in the drawing.

It's the to-and-fro wave movement (rather than the more obvious up-and-down) that transmits energy most efficiently, so Salter allowed for water's normal circular pattern. Avoiding bobbing mechanisms, such as floats, he concen-

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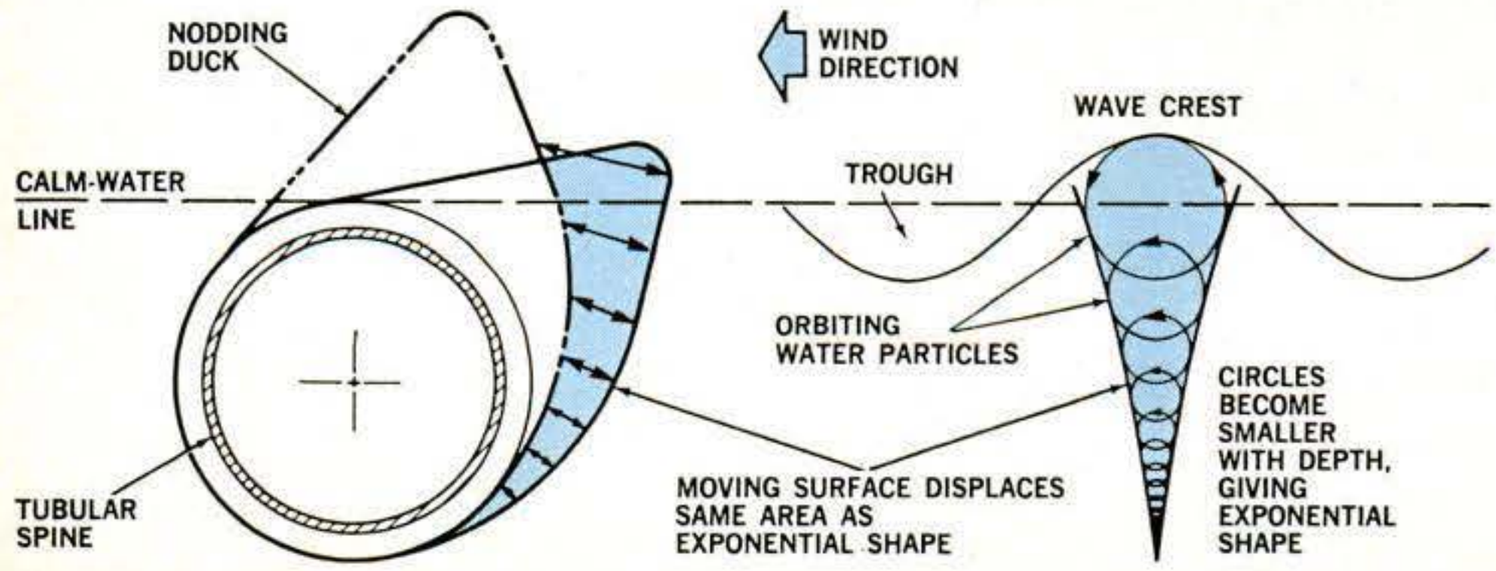
First outdoor prototype had two six-meter, 12-duck strings in Draycote Reservoir, near Coventry. Pumps delivered 30 watts of power ashore.



How it works: Nodding duck absorbs lateral wave force that would otherwise be transferred to next wave. As it rocks, the paunch displaces the same area as the curved-V shape below the wave crest. Close matching of wave and duck diameters is needed for efficient energy transfer. On downstroke, sucking action of trough supplements gravity for positive two-way action. In calm water, ballasted duck floats with only the nose and flat back above the surface.

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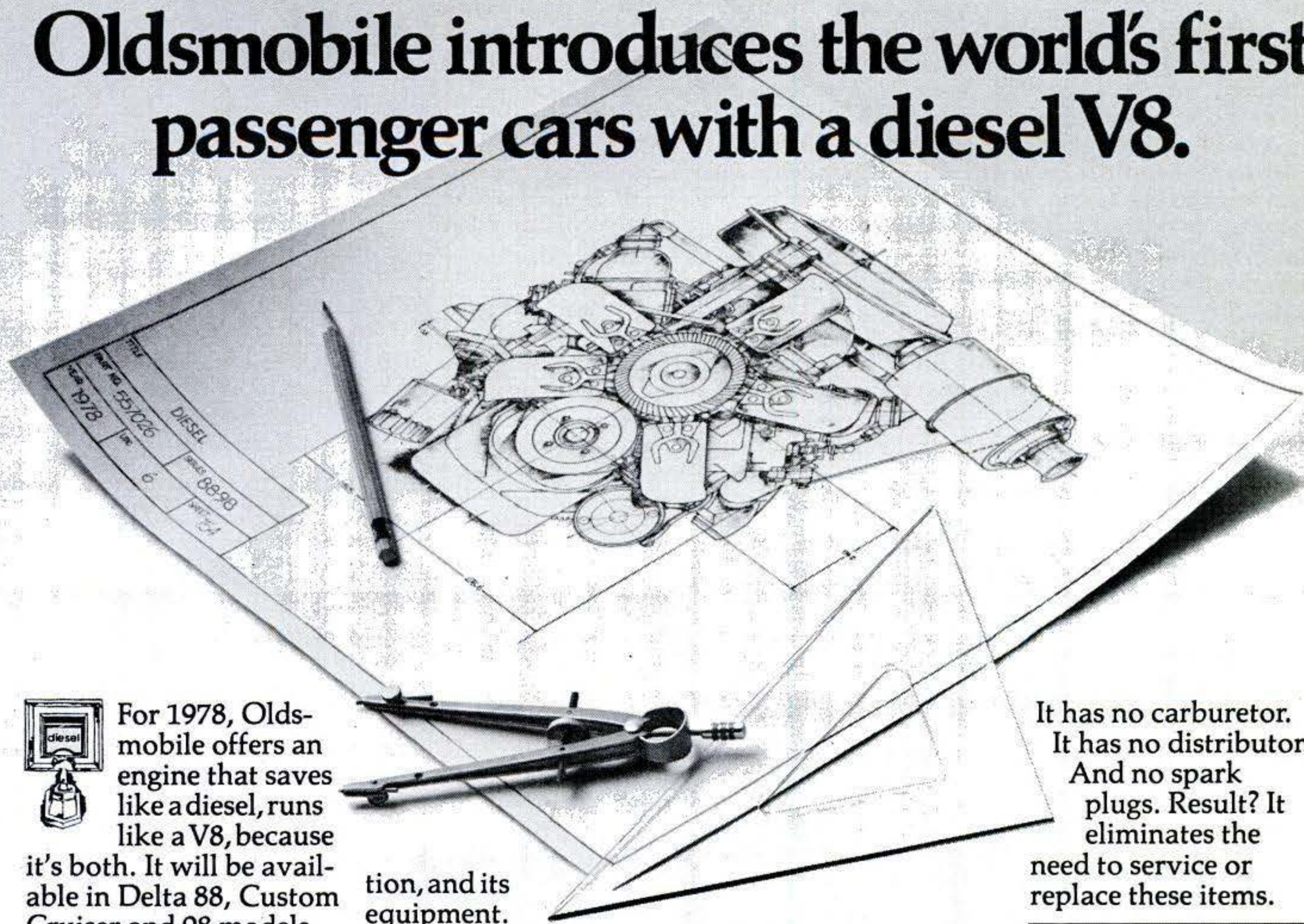
Oldsmobile introduces the world's first passenger cars with a diesel V8.



For 1978, Oldsmobile offers an engine that saves like a diesel, runs like a V8, because it's both. It will be available in Delta 88, Custom Cruiser and 98 models. And it combines the basic economy of a diesel with performance you might not expect from a diesel.

DIESEL ECONOMY

Diesel *means* fuel economy. That's what a diesel is all about:

1978 EPA MPG ESTIMATES WITH DIESEL V8 ENGINES

	Hwy.	City	Comb.
Delta 88	30	21	24
Ninety-Eight	30	21	24
Custom Cruiser	27	19	22

As you can see, these ratings are excellent, for full-size cars. EPA ratings are estimates; your mileage may vary depending on how and where you drive, your car's condition, and its equipment.

Something else to consider: You not only get *more miles per gallon* with a diesel, you also get *less cost per gallon,* based on traditionally lower prices for diesel fuel compared to unleaded gasoline.

V8 DESIGN

Diesels have been around since the 1890s. And response and acceleration have never been their strong suit. But you'll be pleasantly surprised by these new diesel-powered Oldsmobiles.

This new diesel V8 has one of the highest power-to-weight ratios among diesel cars on the road today.

It offers acceleration and a liveliness that the most powerful diesel foreign cars in America don't have. And it's quiet for a diesel, too.

NO SPARK PLUGS NO CARBURETOR

The new diesel V8 simply does not have many of the components that require tune-ups.

It has no carburetor. It has no distributor. And no spark plugs. Result? It eliminates the need to service or replace these items.

TEST DRIVE A DIESEL AT YOUR OLDS DEALER'S

Only your Olds dealer can offer you a selection of V8 power —diesel or gasoline— in a passenger car. No other dealer can make that statement.

In fact, we have made many strong statements about the new diesel V8. We invite you to put them to the test. Stop in at your nearest Oldsmobile dealer's and ask for the keys to an Olds 88, 98 or Custom Cruiser equipped with this remarkable diesel V8 engine.

In this day and age, it's certainly worth checking out.

Oldsmobile

Can we build one for you?

GM

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[*Continued*]

trated on rocking devices "to make a wave think it was driving another wave."

In profile, a semicircle at the rear of the duck extends into a bulging paunch on the underside and straightens out near the rounded beak. A flat back completes the outline. A buoyant unit is ballasted so that all but the beaks and backs are submerged in calm water; when the ducks are lifted by a crest, gravity returns them into the following trough.

Prodigious bird

Pivoting on the circle's axis, each duck presents a curved surface to an oncoming wave that is mathematically matched to the exponentially diminishing orbital pattern of water particles. Equal-area displacement allows the system to absorb most of the energy in the water without rotary drag or disturbance of normal wave motion. "The wave doesn't notice anything different," as Salter puts it.

Since the ducks nod independently and out of phase, the free-floating spine stays put as a stable reference, and hydraulic delivery from paralleled pumps is smoothed.

Assuming a perfect wave-to-duck match, theoretical energy transfer could reach 96 percent. Ocean waves vary in size, however, so actual efficiency is more like 60 percent. But even that leaves an enormous potential for this highly concentrated form of sea power.

The first outdoor prototype was set up in a sheltered-water reservoir near Coventry in April, 1976. The 1/50-ocean-scale prototype was built at nearby Lanchester Polytechnic, which is responsible for the project's large-scale engineering.

Nodding through 45° arcs on their tubular spines, the 35-cm-diameter ducks operate bellows pumps that force water ashore through a common pipe. Output was 30 watts (sufficient for a car headlight), considered encouraging enough to move ahead to the next stage: Loch Ness.

Flanked by steep hills in the Scottish Highlands, 22-mile-long Loch Ness—swimming hole of a fabled monster—is rippled by funneled wind to about 1/15 ocean scale. Sized to that ratio, a 50-meter-long spine carries 20 ducks, each a meter in diameter. A geared hydraulic transmission drives a 20-kw alternator. The assembly is instrumented to check spine dynamics, induced forces, anchoring strains, and other critical factors.

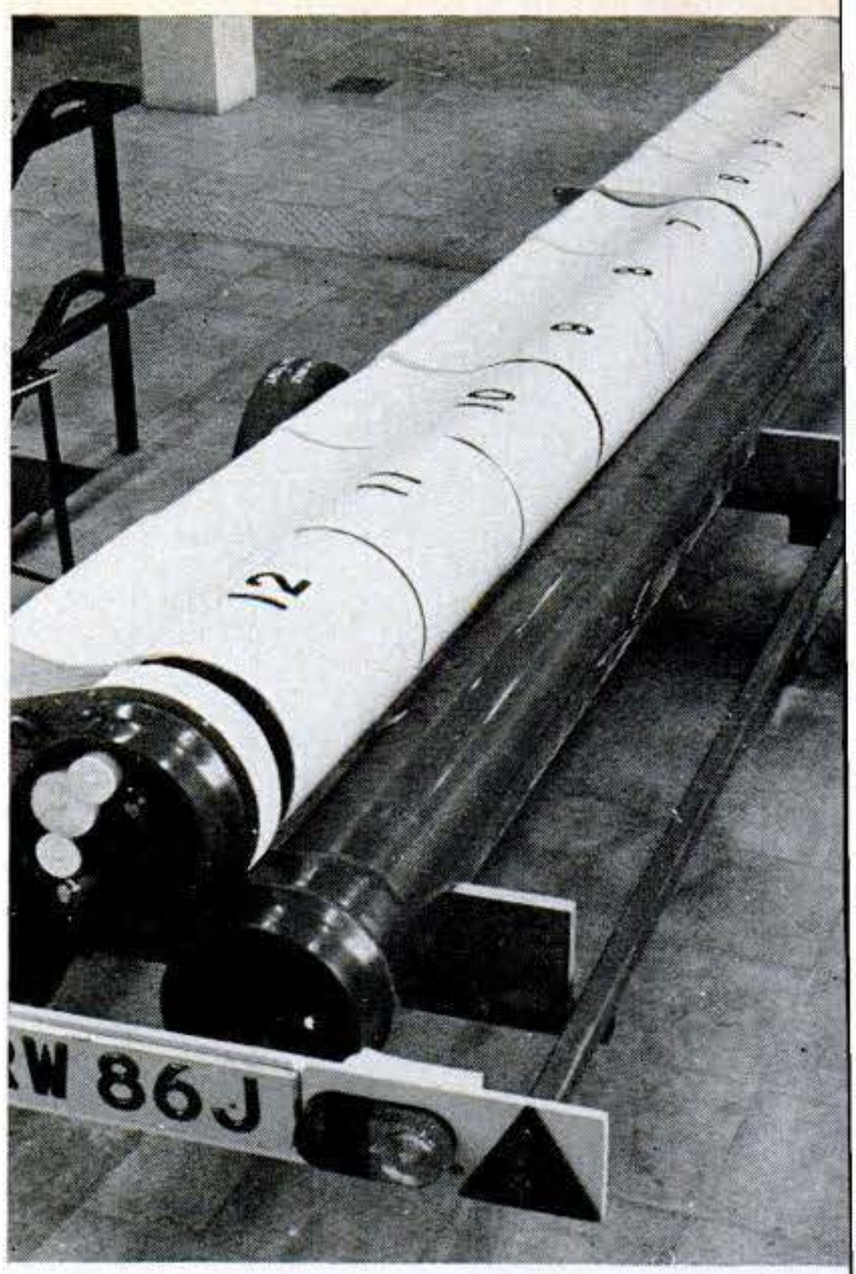
According to Dr. Norman Bellamy, director of the Wave Power Project at Lanchester, Loch Ness should show "how the device survives and operates in a natural wave climate." He hopes it will lead to the next stage, a quarter-scale seagoing model in the estuary of the River Clyde, near Glasgow.

Lanchester's final target is a full-scale open-sea plant to be moored 10 miles west of Scotland's Hebrides Islands where prevailing westerlies, blowing across 3000 miles of ocean, form what may be the richest wave field in the world. Here, a one-kilometer string of house-high, 15-meter-diameter ducks would take energy from waves that pound away at 10-second intervals and average three meters in height. Alternators and converters would feed an estimated 45 Mw into the national electricity grid.

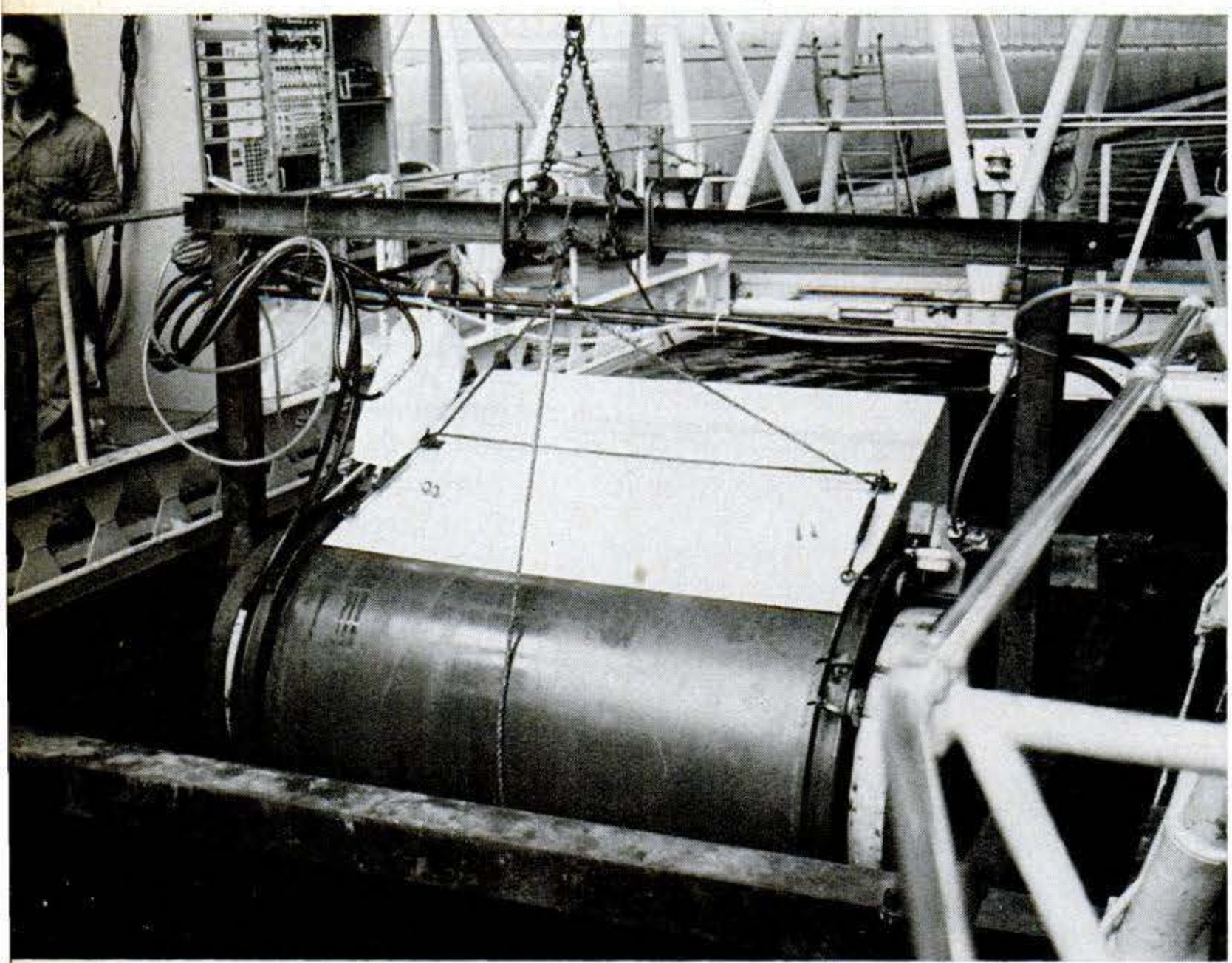
A single Y-form line would moor the vast floating machine to an anchor, leaving it free to swing around in the wind and face oncoming waves as they change direction.

Is such a machine just a wild duck chase? Can it really happen? "So far," says Dr. Bellamy, "we have every reason to believe it can."

If his vision is realistic, Britain can look forward to a 500-kilometer offshore array of nodding ducks. Producing all the electricity the country now uses, it would truly harvest the inexhaustible energy from the sea. PS



Fiberglass 12-duck string, above, was built to 1/50 ocean scale for test in Draycote Reservoir. "Ducks" operated individual pumps.



Scaled to 1/15 ocean-wave height, forward section of Loch Ness duck was tank-tested on metal drum with reciprocating pump, left.

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A special type of asphalt can take the pollution out of paving.

Paving with cutback asphalt releases fumes and uses petroleum needed elsewhere.

As a surface material for modern highways, asphalt is practically ideal. Because it's smooth and durable, and also quite economical. Yet the typical paving process, using "cutback" asphalt, pollutes the air and wastes valuable petroleum.

The pollution comes from kerosene and other solvents used to liquify the asphalt for handling. When the hot asphalt is applied to the roadbed, the solvents escape into the air. And since the solvents are a form of petroleum, they represent a significant loss of oil – up to 336 million gallons per year.

Homogenized asphalt

The people of Phillips Petroleum have a solution:

Water-based asphalt cuts air pollution and uses 30% less petroleum.

a water-based asphalt which eliminates the solvents and uses thirty percent less petroleum products to surface a mile of highway.

Asphalt is a form of oil, so it doesn't normally mix with water. But in a process much like homogenizing milk, the asphalt is broken into tiny particles and made to mix with water. The result is something called an "asphalt emulsion."

This asphalt/water mixture is applied to the roadbed. As the water evaporates, a solid highway surface is formed. A surface just as smooth, durable and economical as that produced by the old method.

Yet there's one big difference. Because no solvents are used, there are no fumes.

Less pollution, less wasted petroleum.

Only water goes into the air, so pollution is cut dramatically. And since petroleum-based solvents aren't needed, thousands of gallons of oil are saved on every highway built with this process.

Taking the pollution out of paving, while making fine products for your car. That's performance. From Phillips Petroleum.

The Performance Company

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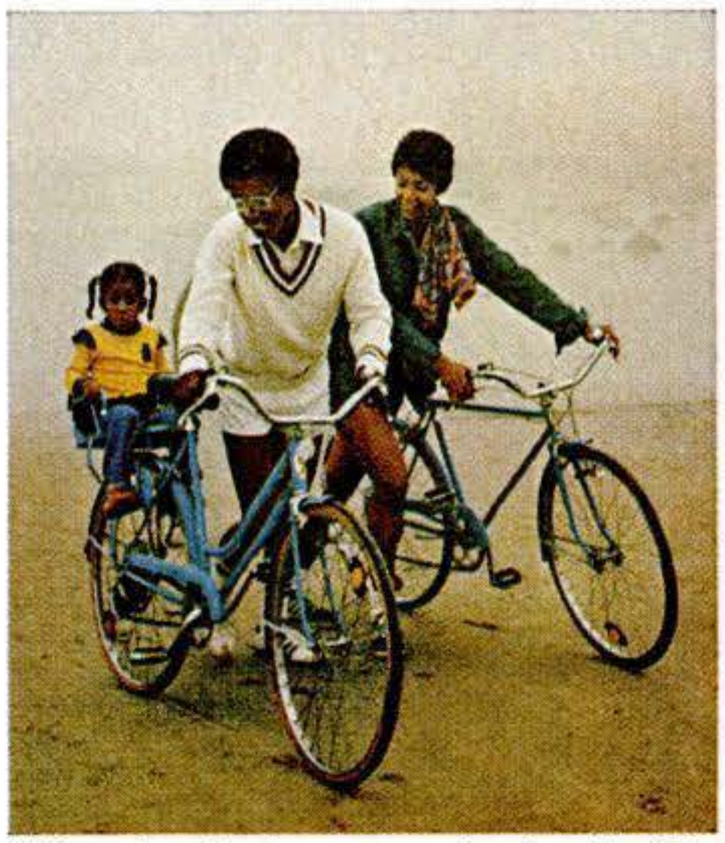

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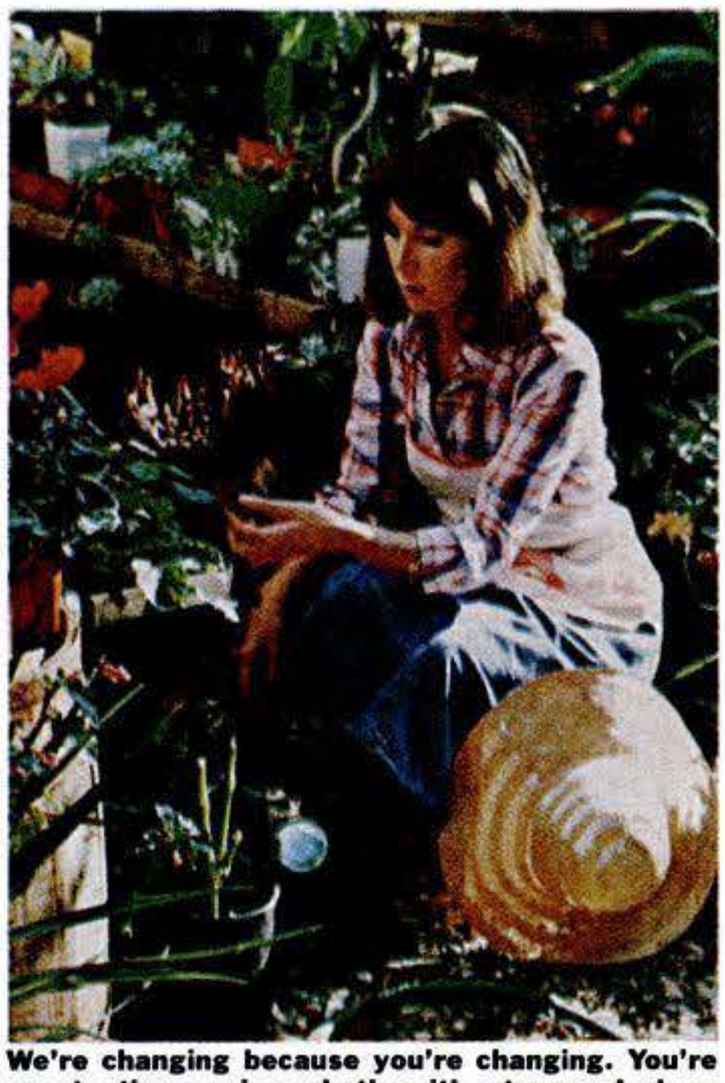

We're changing because you're changing. You're constantly growing whether it's at your desk or in your garden.

We're changing because you're changing. You're not just going on vacation, you're building a vacation home.

Like you, we're not changing overnight. And until you receive your new Visa card, your BankAmericard is welcome wherever you see the familiar Blue, White and Gold sign. But soon, the name you'll be seeing and the card you'll be using is Visa.

We're changing because you're changing.

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Button-free Micro Recorder

A new micro recorder that turns on at the sound of your voice may revolutionize the entire personal recording industry.

The idea is simple yet the results are very dramatic. Olympus, the famous precision camera company, has developed the world's first voice-activated micro cassette recorder—the Olympus SD.

RECORD WITHOUT BUTTONS

The unit has an optional voice activation switch (VA switch) that automatically turns on your recorder at the sound of your voice. If you drive in your car or do dictation in your office, just talk to your unit. It does the rest. It will turn on to record your comments and turn off when you stop talking.

The VA switch has a three-position sensitivity control. You can set it for low sensitivity while driving your car so only the close proximity of your voice will turn it on. In the middle sensitivity position, you could use the unit in conferences or for dictation in your office. In the high sensitivity position, you could even leave the unit in your desk and it would record all the sounds in your office—perfect for private detectives.

The VA switch has other advantages. It makes your tapes more efficient by making them last longer since your unit turns off during long pauses. So the unit's sixty minute tapes might be the equivalent of seventy or eighty minutes on other systems.

ACCESSORY MODULES

The VA switch is one of a series of small modules that plug into the bottom of the SD, thus expanding the recording system. These modules include an AM or FM radio module that plays music and news directly into your unit, a power amplifier and speaker that play back your tapes with high fidelity for conferences or personal music enjoyment, a telephone pick up that will record both sides of a phone conversation and a clip-on microphone for conferences or speeches. There are also a separate transcriber, foot pedal and headset available for your secretary.

MOTOR DRIVE BREAKTHROUGH

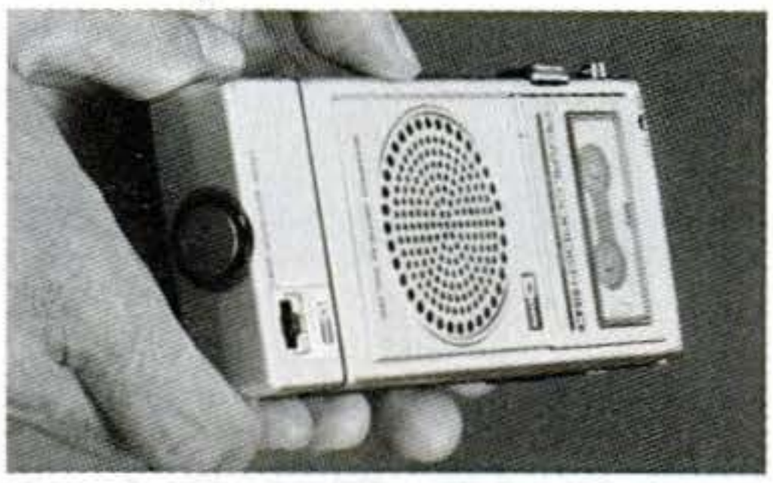
The Olympus SD has several new recording breakthroughs. The first is the new coreless motor. Conventional motors require a wire-wound long, solid core. In the Olympus coreless motor, the windings are on the outside or stationary part of the motor making it flatter, yet it has greater initial torque and more consistent speed than any conventional unit. Because of the coreless design, the entire SD unit is lighter, flatter, and easier to carry. There is less vibration, noise and power consumption so your batteries last longer and your recordings sound cleaner.

RECORDING HEAD QUALITY

The unit uses ferrite for its recording heads—the same material used in precision studio recorders. This extremely hard, diamond-like material will never wear out and prevents oxide build-up on the heads. You have top recording quality without wear.

NEW MICROPHONE TECHNOLOGY

The new built-in electret condenser microphone with automatic level control is also a major design advance. Through new electronic circuitry, the impedance of the microphone remains constant, thus passing on the natural sound quality of all frequencies without distortion. The result is a clear recording with an extremely low signal to noise ratio so you won't hear objectionable background hissing or humming.



Just plug in the VA switch and you can operate the SD without pressing its record and pause controls. The basic unit measures only 7/8"x 2½"x 5½" and the VA switch adds another inch to its length.

VERY RUGGED UNIT

With all its quality and breakthrough features, the Olympus did not lose touch with reality—namely, that personal recorders get dropped, stepped on and damaged. Even if you're careful, there's always a chance you may drop or damage your unit.

The Olympus SD was built with both special cushioning features and component design that literally permit you to abuse your unit while still maintaining the same recording quality. The most sensitive component has always been the motor. If a conventional unit is dropped, even a slight motor core misalignment will noticeably affect performance. With the Olympus SD motor, there is no core, so core misalignment is impossible. Olympus also maintains a prompt service-by-mail facility if service should ever be required. Just slip your 12 ounce recorder in its handy mailer and it's on its way. Service should never be required but it's always good to know that your unit is solidly backed by a responsible service organization.

AUTO SHUT-OFF

Some units have automatic shut-off at the end of a cassette during the record mode. So does the SD. But the SD also has this feature on playback, thus preventing tape stretching and battery waste. And when the unit does shut off, it's practically silent and does not attract attention.

QUALITY FEATURES

The tape is capstan driven—the best drive available in cassette recorders. It can play eleven hours on a set of two penlight batteries and optional rechargeable batteries are also available. The Olympus sixty minute cassette (30 minutes per side) costs only $2.99 compared to $4.99 and $5.99 for other brands. This gives you the lowest cost per minute recording of any system available.

JS&A offers you the most important breakthrough product in micro cassette recording. Olympus' voice activation switch, its new coreless motor, ferrite tape heads and electret microphone mean both quality, value and advanced technology—years ahead of all others. And the price of the Olympus SD is actually less than many of today's more popular brands that do not yet have the SD's innovations.

Olympus is the company that invented the micro recorder in 1969. Since then, they have licensed dozens of other companies to produce them—yet no unit compares with the Olympus. JS&A is America's largest single source of space-age products and a company that has brought to market the most advanced new products of this decade. We feel the SD is one of them.

But don't take our word for it. We suggest you order just the Olympus SD and the VA switch. Then use the system for thirty days. Take it with you to work, keep it in your pocket when you travel, and use it to dictate your notes. Compare the Olympus to every other unit on the market and read all the consumer reports on recording devices. Then after thirty days, decide whether or not the Olympus will quickly pay for itself in convenience and in actual time savings. If not, then return your unit for a prompt and courteous refund. If you decide to keep the SD you will positively own the best personal recorder sold today at any price. Then you can order any of the additional accessories available with the system from our inventory. Remember, there is no obligation, no postage and handling and you take absolutely no risk.

To order your unit and VA switch send $269.90 (Illinois residents add 5% sales tax) to the address shown below or credit card buyers call our toll-free number below. By return mail we will send you your Olympus SD, VA switch and one year limited warranty. Or you may order any of the other items listed below.

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CALCU-LETTER

By DARRELL HUFF News of pocket calculators—and how to have fun with them

That popular puzzle

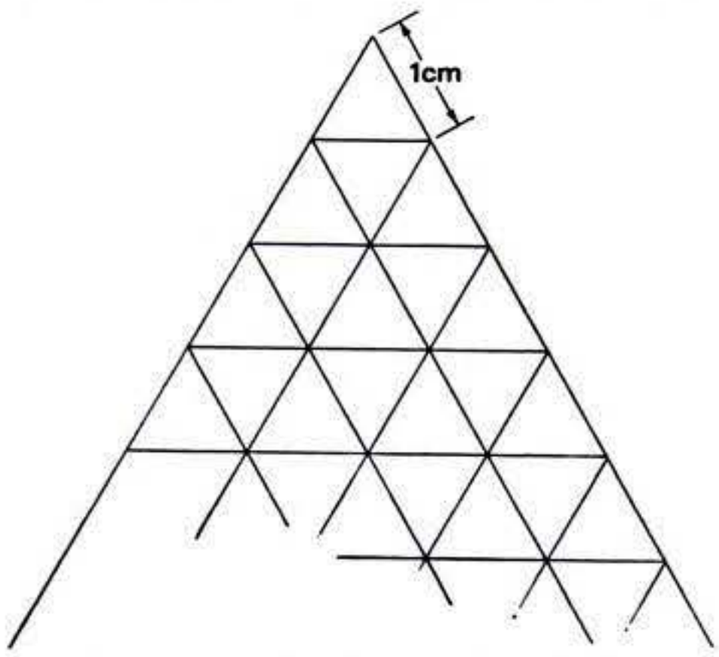
What came to be called "The Incredible 37-Year Puzzle" took up only a few inches in *Popular Science* when it appeared last February, but it produced a flood of letters; we gave you a sampling last month.

Along with their solutions, right and wrong, many readers offered thanks for an excuse to dust off their pocket calculators. Quite a number asked for more puzzles and problems, preferably ones on which they could use their little magic boxes.

Jeffrey P. Hardy of San Diego offered a question about a large equilateral triangle in which a multitude of smaller triangles had been drawn. Quite a yarn could be made up about a pattern like that.

Pyramid poaching

Traveling in a far country, you come upon a small, regular pyramid of which each side is an equilateral triangle inlaid with smaller triangles of precious



metals studded with jewels. Having determined, most regrettably, to make off with this ancient object, you measure a side of one small triangle and find it to be just one centimeter. Counting all sides, you also find that the total number of small triangles is 39,605.

To further your wicked plan, you must construct a rectangular box in which the precious pyramid can just stand upright. How high must this box be?

If you run into trouble designing the box, be around for the next installment of this column (in the January '78 issue) for a discussion of and solution to this problem and a couple more we'll get to in a minute.

Many roads to a square root

Meanwhile, it wouldn't surprise me if in connection with at least one of the problems you found need to derive a square root. Next best thing to the square-root key that is increasingly common on calculators is an approximating formula. But this is easily forgotten, too, which brings us to guess-and-try, guess-and-try. Surprisingly, this method—if you can call it that—is reasonably fast and very precise.

Let's say you want the square root of 2189.3. You can see that it must lie between 40 (of which the square is 1600) and 50. Entering 45 and—with most calculators—touching times and equals keys gives you its square as 2025. A little small, so try 47 (just too big) and then 46.8 and finally 46.79, which is on the nose. At least that's the sequence I followed and it took me about two minutes.

Is this feasible with longer numbers? For the square root of 2189.3061 I started with the previous result and needed just three more minutes to reach an answer of 46.79002, which is really carrying things too far.

Considering what a chore cube and fourth roots and so on used to be, you may be surprised to discover our cut-and-fit approach yields them almost as quickly as it does mere square roots.

Great escape

Whether or not you need to find any roots for your box project, you may be glad to know the technique if your effort to steal the jeweled pyramid ends in deserved disaster. You might, that is, if for your indiscretion you and your calculator were imprisoned within a circular stone wall and issued an ultimatum. With no measuring devices to be supplied, you will be allowed to live only if you can answer with reasonable accuracy:

1) How far is it around the wall?

2) How long must a ladder be to reach the top of the wall if the foot of the ladder is placed nine feet from the wall?

After rather more physical activity than is suited to the hot though sunless day, you run a few figures through your calculator and announce your estimate of the wall circumference.

"Correct well within five percent," your captors confirm. So you ask for a bowl of cool drinking water and retire to a comfortable spot to consider the more difficult problem.

For your own good, I hope the calculator you have in your pocket is one you've used before. Otherwise you may have an

Continued

10 years ago your hair didn't need the protein it needs today to look its best.

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[*Continued*]

experience as baffling as I did while checking methods of squaring on several different calculators. One, nipped from the purse of my wife, who seldom allows it to reach my clumsy hands, is a gem of a mini, a Casio Pocket LCII. To save my life I couldn't figure out how to use the constant, a feature I knew must be there, as it is on just about every calculator built today.

It was as frustrating as the time I borrowed one of those bulldog-faced midget Fiats and parked it nose-to-stone-wall before discovering that I didn't know where it kept reverse gear. My passengers finally had to push me out of that one.

With the mini, my wife came to the rescue with a tiny booklet and the irritating, if familiar, advice: "If everything else fails, read the instructions."

Darned if you don't operate the constant on this model by punching the times (or divide) key *twice*. What will they think of next!

Very small or very very small

Actually they have already thought of the next thing. Since our LCII is a year old it has to be out of date, things being as they are in the calculator market. Though hardly half a handful at 88 grams (just over three ounces) it has been supplanted by models even easier on batteries—or even tinier, as with the sub-minis you see below. If it's size (or lack of it) that sends you, you could have trouble choosing between Casio's Micro-Compact and Micro-Mini. The MC-811, at left, is a jewel in its gold-tone protective case that operates an automatic turn-on and shut-off feature.

MICRO-COMPACT (MC-811) MICRO-MINI (M-810)

At a mere 2.4 ounces, it is nevertheless twice as heavy as the M-810 at right, billed as the world's lightest and smallest calculator—this week anyway. And that weight includes its silver oxide battery that should run it continuously for more than 60 hours. Suggested retail price is about $35 for the Micro-Compact, $5 more than the lighter Mini. Both have the usual four-function features, along with percentage key, and an automatic-accumulation memory, and keyboards designed for one-hand operation.

How to ship a 10-foot pole

"I wouldn't touch you with a 10-foot pole," I shouted, and banged down the receiver. To emphasize my point, in my jealous rage, I decided to ship her one.

But I ran into a problem. Although the shipping company offered no objection to a pole, or even to revenge, they had a firm rule against accepting any object or container more than 72 inches on the longest side.

Is there any way that I could ship my 10-foot pole without spoiling its point —and mine—by cutting, breaking, or bending it? See you in January PS

Author of How to Lie With Statistics *and* How to Take a Chance, *among others, our calculator columnist Darrell Huff (P.O. Box AS, Carmel, Calif. 93921) will welcome comments, solutions, suggestions.*

CAN YOU OUTSMART OUR COMPUTER?

Don't be too sure. The computer built into Parker Brothers' new game Code Name: Sector™ is capable of making thousands of calculations per second. It's as powerful as early computers that filled entire rooms and sold for millions of dollars. And, while it gives you clues to track down and sink a hidden electronic submarine, it also helps the sub escape and counter-attack. That's the catch that makes every game a real challenge. Whether you're playing alone or against others, your toughest opponent is the computer. Code Name: Sector™, the new electronic board game from Parker Brothers. It's a game with a mind of its own.

PARKER GAMES

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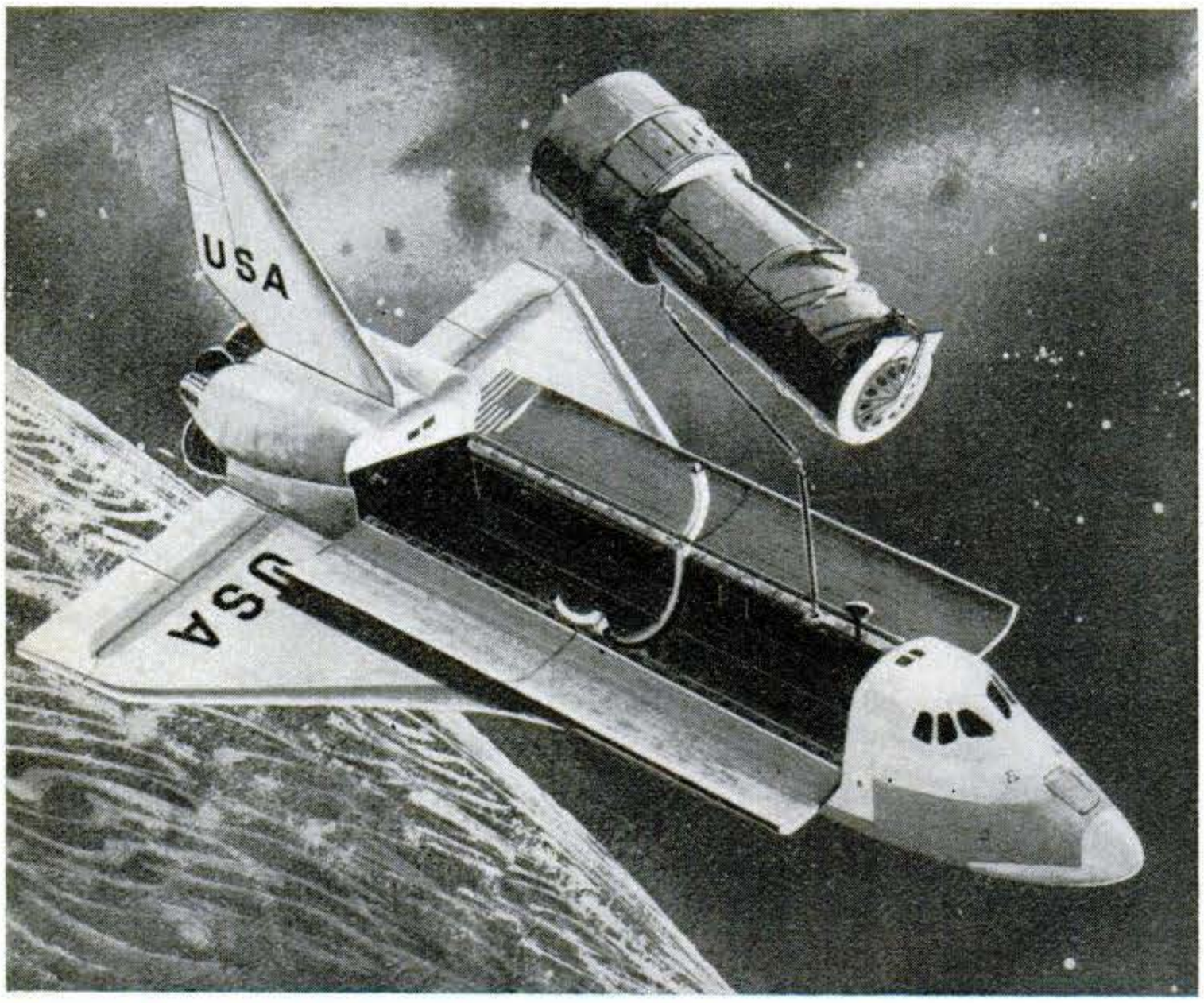
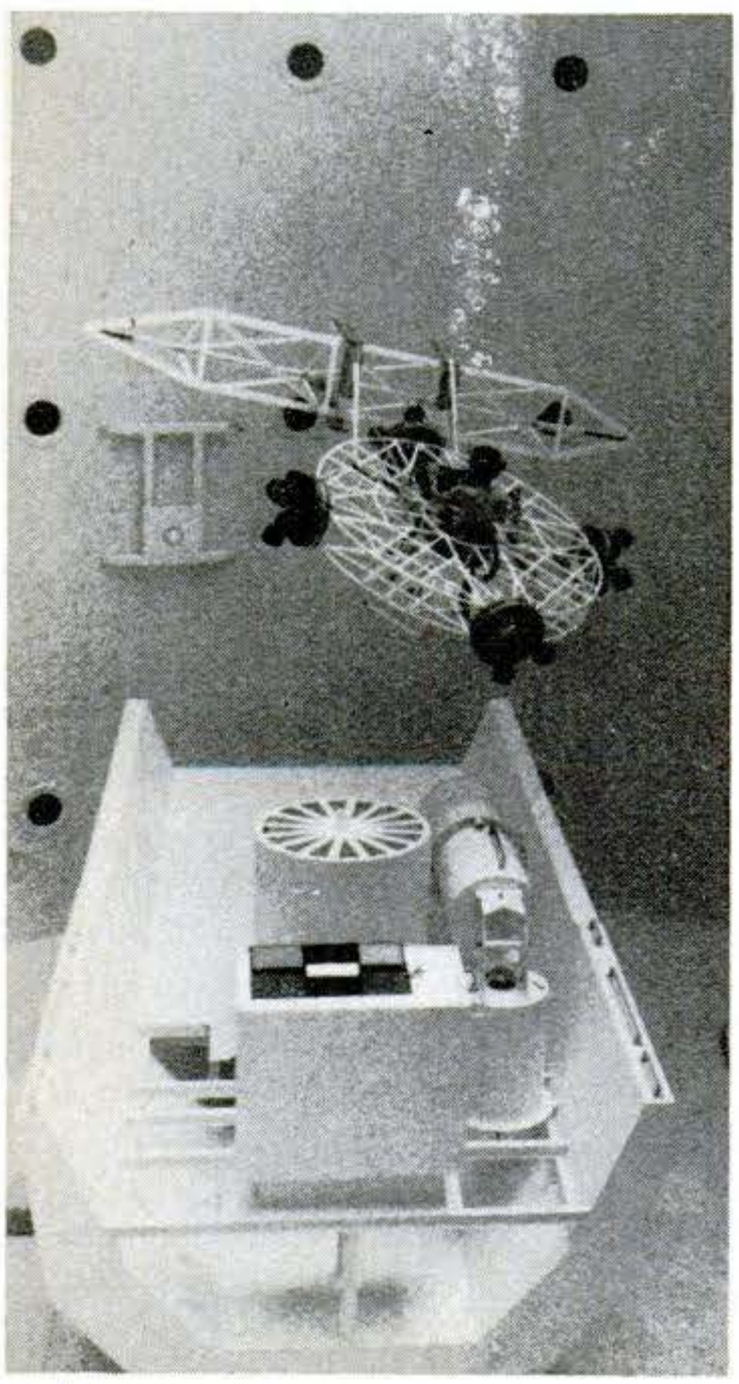
SCIENCE NEWSFRONT

BY ARTHUR FISHER



Space shuttle to get space telescope for clearer view



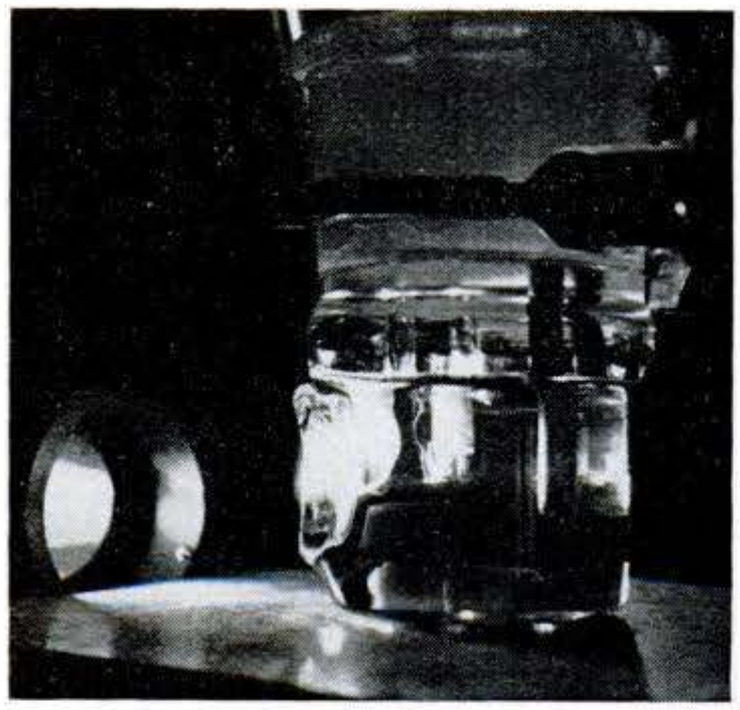
There's a winner in the long struggle over who would design and build the major part of the space telescope that will be lofted into orbit aboard the space shuttle in 1983. NASA has announced that Lockheed Missiles & Space Co. in Sunnyvale, Calif., will build the basic telescope structure, called the Support Systems Module—about 43 feet long and 14 feet wide—and will also integrate the telescope's optics and instruments into the structure. The new telescope, seen deployed in the artist's concept above, will have 95-inch-diameter optics. Orbiting some 300 miles above Earth, well clear of the murky atmosphere that fogs the vision of much larger land-based instruments, it will far surpass them: The new telescope should peer seven times deeper into space, make out objects that are 50 times fainter, and do so with a resolution seven times greater than ever before achieved—perhaps even spotting planets of other solar systems.

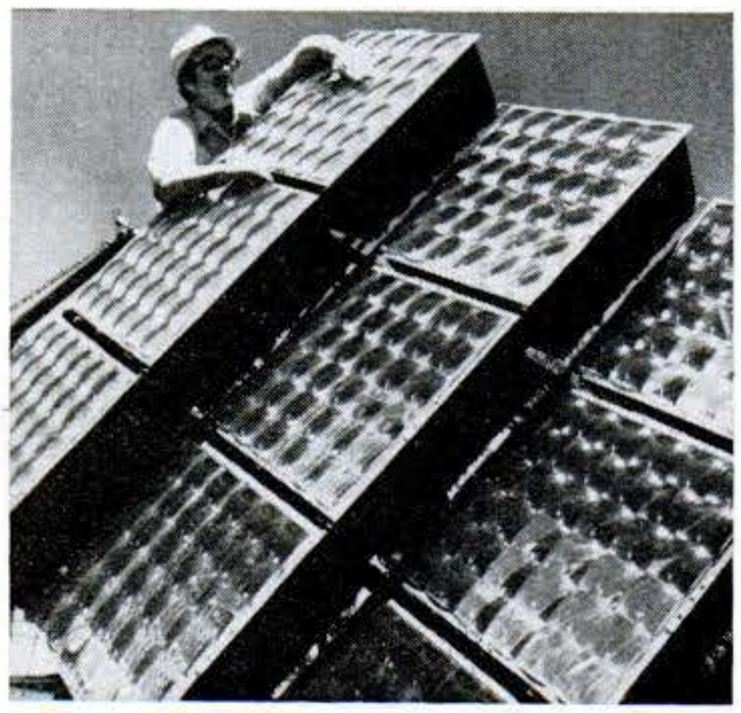
Another extension of space-shuttle capability that's being explored is shown in the photo at left. A mock-up of the shuttle's cargo bay rests at the bottom of the Neutral Buoyancy Simulator at the NASA-Marshall Space Flight Center. Filled with water, the 40-foot-deep tank mimics the weightless environment of space. Above the bay, an operator pilots the "Free Flyer," a simulated space vehicle propelled through the water by small electric trolling motors, much as thrusters would propel a spacecraft—or a space-suited astronaut—through space. In this test of space construction techniques the operator is manipulating a prefabricated steel beam. Very large structures will someday be assembled in space using similar methods.

Solar-cell progress

Two different approaches to improving photovoltaic solar cells, which turn sunshine directly into electricity, are shown in this pair of pictures.

The top photo shows a "liquid-junction" cell developed by physicists at Bell Laboratories. All solar cells produce the photovoltaic effect at the junction of two materials, traditionally two solid semiconductors. In this cell, two electrodes are immersed in a solution of sulfide polysulfides in water. One electrode is a semiconductor, the other is carbon or a metal. When light falls on the semiconductor electrode, current





flows through the liquid. The concept, Bell Labs scientists think, may yield a longer-lived, more economical solar cell than the solid ones.

At RCA Laboratories, researchers are sticking with conventional silicon solar cells. But they are covering them with arrays of inexpensive plastic lenses (bottom photo) that focus sunlight onto the cells at a concentration of 300 times, so much smaller cells can be used. The 300-watt experimental system is being developed for ERDA.

Continued

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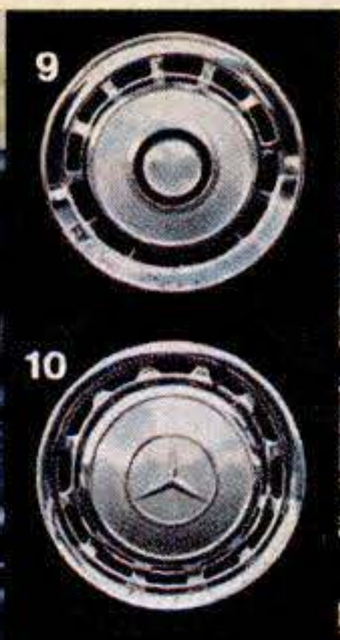

Check which car you think is which and compare your answers with those at the bottom of the page.

	1	2	3	4	5	6	7	8	9	10	11	12
GRANADA ESS												
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Answers: **Granada ESS: 1, 4, 5, 7, 9, 12. Mercedes-Benz: 2, 3, 6, 8, 10, 11.**

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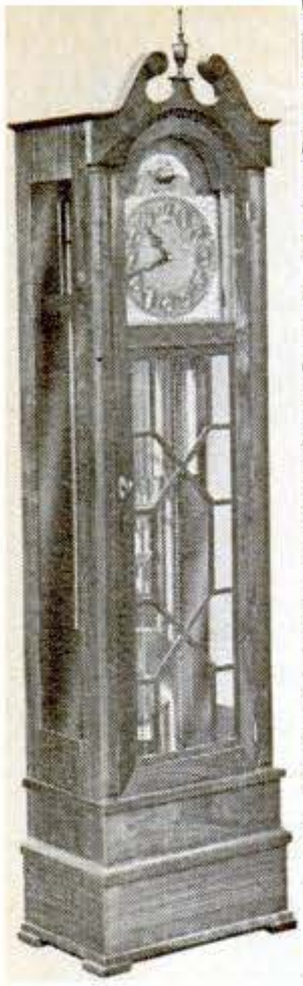

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Windmills and TV

"Windmill blades slicing the air to produce pollution-free power can also slice nearby TV [picture] reception to tatters." That's the conclusion of Thomas B. A. Senior, a professor of electrical and computer engineering at the University of Michigan, who has been studying, for ERDA, the effects large-scale wind turbines might have on FM and TV reception. The higher the broadcast frequency, he finds, the worse the interference; and the larger the windmill blades, the farther away from the device TV picture reception suffers.

Bright idea

Lincoln Laboratories of M.I.T. has developed a new chemical film that could, it is claimed, reduce the electrical-energy consumption of a light bulb by 60 percent with no loss in light output. The school has signed a licensing agreement with the Duro-Test Corp. giving that maker of light bulbs and tubes exclusive rights to the new film. A research program at M.I.T. will now begin to develop an incandescent lamp using the film as a coating inside a spherical glass bulb.

According to Professor James D. Felske of the M.I.T. Department of Engineering, principal investigator on the project, the new coating would transmit visible light, but simultaneously bounce back infrared radiation to the center of the bulb. This would help keep the glowing filament hot, and thus reduce the amount of electricity needed to maintain the filament at the proper temperature.

Ordinarily, about 90 percent of the electric power consumed by a 100-watt incandescent light bulb is wasted as heat, about 80 percent of it in the form of infrared radiation. With the new coating, a bulb that gives as much light as the current 100-watt bulb would consume about 40 watts of electricity.

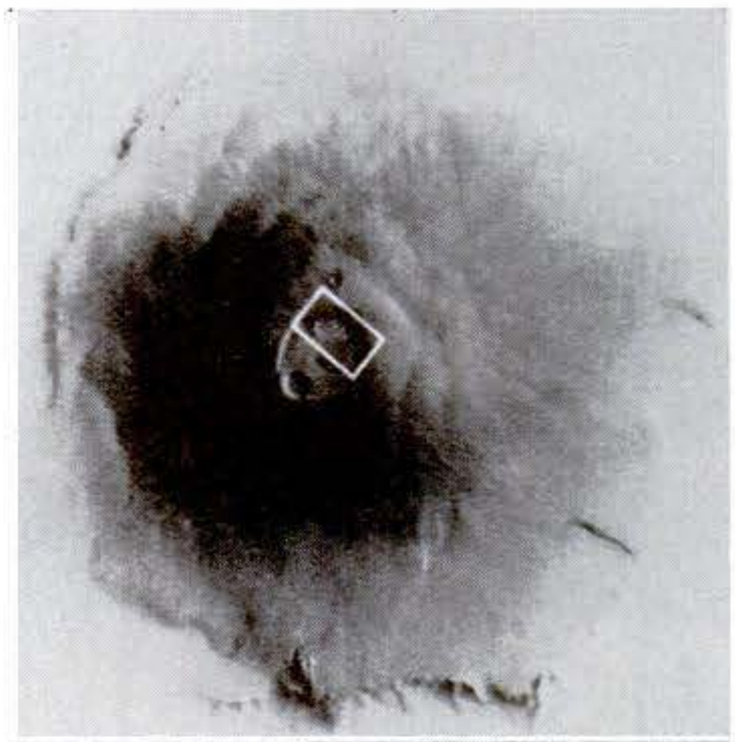
According to the president of Duro-Test, G. Raymond McGruther, this energy-saving development could utterly change the nature of the incandescent-light-bulb industry.

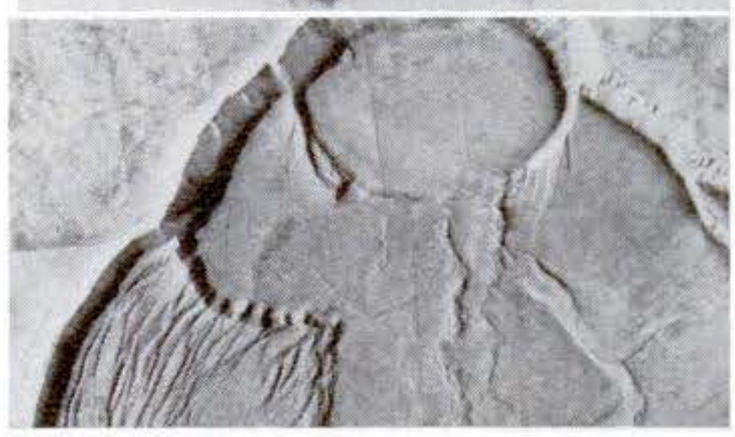
Castor oil for plastics

Chemicals produced from petroleum are used extensively to make a wide variety of plastics and rubber-like materials. With the dwindling of our petroleum resources, there has been a search to find substitutes for these petrochemical-based products. Now a team of chemists at Lehigh University, working with researchers in Colombia, South America, and supported by the National Science Foundation, has found that castor oil and other vegetable oils—such as linseed oil—can be polymerized to make tough, rubbery plastics. These renewable resources could thus be used to make a number of products—shoe heels, for example.

Martian volcano

How much more do we know about Mars today than we did five years ago?





The answer fills hundreds of volumes. One vivid illustration of just one small aspect of this knowledge explosion is the contrast between these two pictures. At the top is a photo made by Mariner 9 in 1972 of Olympus Mons, a gigantic Martian volcano that dwarfs any similar feature on Earth. The mountain is 600 kilometers across at its base with a crater 65 kilometers wide that looms 23 kilometers above the dusty Martian plain.

Now look at the lower photo. Taken by Viking Orbiter 1 in 1977, it covers that part of the crater outlined in white on the old Mariner photo. It shows with extraordinary clarity fine details of the complexly varied volcanic vent. Amazingly, features as small as 18 meters across can be seen!

Largest windmill

The newest—and biggest—of this country's giant experimental windmills will be built in late 1979. Boeing Engineering and Construction Co. will design, build, and test the giant turbine for ERDA, with NASA's Lewis Research Center in Cleveland managing the project (as it did with the big mill at Sandusky, Ohio—see the PS cover story in March '76).

Size? The blades will span 300 feet, compared with 125 feet for the Sandusky machine. The new turbine, whose site is yet to be selected, will generate 2.5 megawatts. PS

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4, 4.5, 7.5, 9.8, 20, 40 HORSEPOWER

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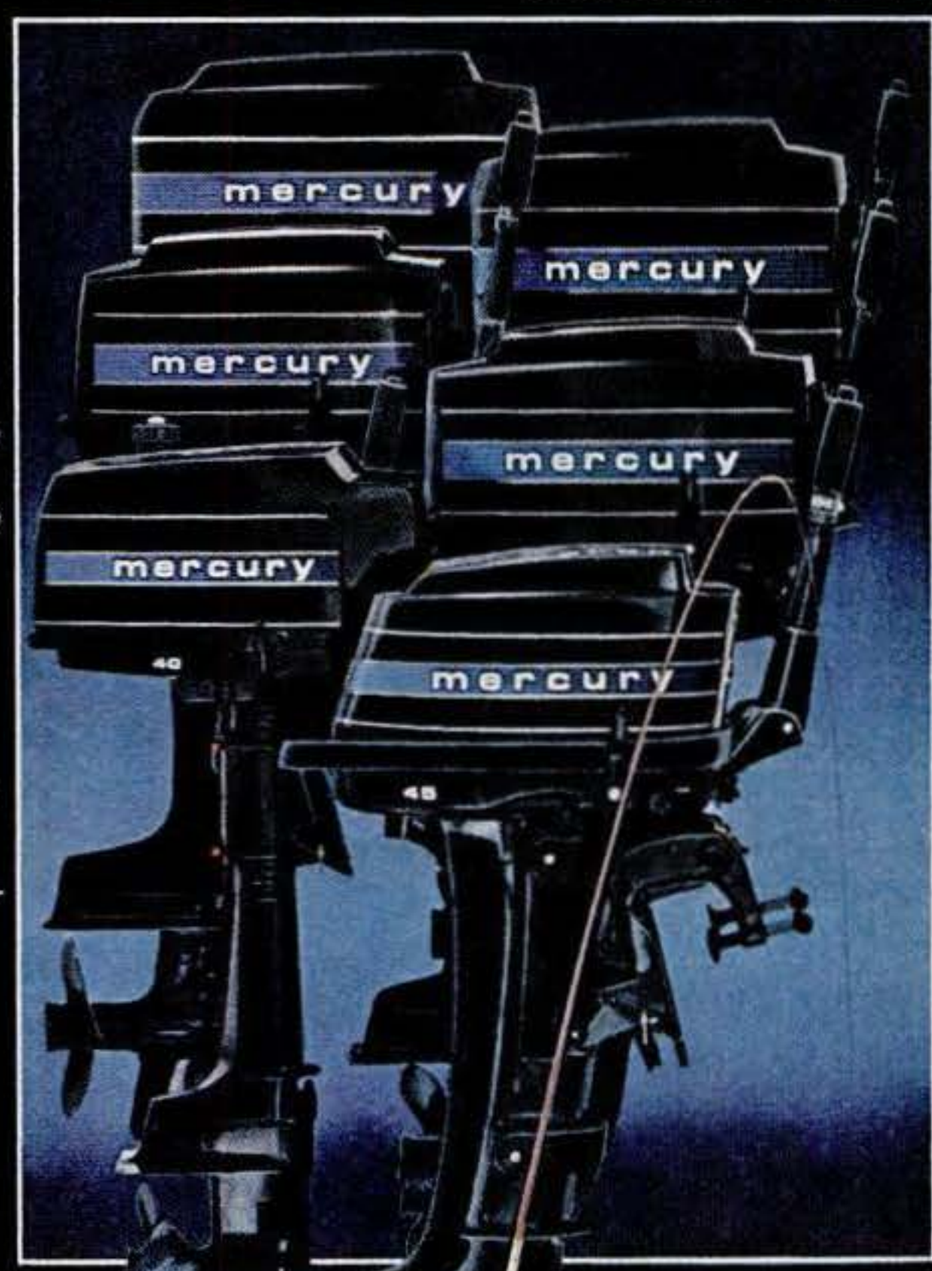

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8. QUIET, EFFICIENT EXHAUST-You don't disturb the peace and quiet, because a Merc exhausts sound and fumes underwater through the prop hub. Saves gas, too--by reducing drag and increasing engine efficiency.

9. SMOOTH, QUIET RIDE-For hours of smooth and quiet riding, the Merc aircraft-type Dyna Float® suspension isolates vibration from the transom.

You'll find many more reasons why Mercury offers you real value in a fishing engine in our "Fishpower Fact Book." It's free from your Mercury dealer. Or send $1.00 to Mercury Marine, "Fishpower Fact Book" 1939 Pioneer Rd., Fond du Lac, Wisconsin 54935.

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IT TAKES A VERY SPECIAL CASSETTE DECK TO GET SO MUCH BEAUTIFUL MUSIC OUT OF SOMETHING THIS LITTLE.

The recording tape in a cassette is only an eighth of an inch wide.

Crammed into that eighth of an inch may be as many as 64 tracks mixed down to two. A hundred musicians. Countless overdubbings. Not to mention the entire audible frequency range.

Any cassette deck can reproduce part of what's been put down on that eighth of an inch.

But the Pioneer 9191 was designed to reproduce all of it. Superlatively. Without dropouts, unacceptable tape hiss, or noticeable wow and flutter.

Take our tape transport system, for example.

Since the tape in a cassette moves at only 1-7/8 inches per second, even the most minuscule variation in tape speed will make a major variation in sound.

To guard against this, where most cassette decks give you one motor, the 9191 comes with two. The first is used only for fast forward and rewind so the second can be designed exclusively to maintain a constant speed for play and record.

All of our tape drive components—the capstan, belt, and flywheel—are finished to incredible tolerances. Which give the 9191 the kind of wow and flutter figures that no deck in our price range can match.

Of course, having a great tape transport system means nothing if you don't have great electronics to back it up.

We do.

The 9191 comes with an advanced three stage direct coupled amplifier that extends high frequency response and minimizes distortion. The built-in Dolby system can reduce tape hiss by as much as 10 decibels in high frequencies.

Our multiplex filter lets you record

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FM broadcasts without picking up a lot of unwanted noise, or the multiplex signal every FM stereo station sends out.

Even our ferrite solid tape head offers the best combination of accuracy and long life you can get in a cassette head.

We also include a peak limiter to let you cram as much onto a cassette as possible without distortion. A memory that lets you go back to a favorite spot on the tape automatically. Separate bias and equalization switches for getting the most out of different brands of tape. And electronic solenoid controls for going from play to rewind, or from rewind to fast forward, without hitting the stop button. And without jamming the tape.

Go slip a cassette into a Pioneer 9191 at your local Pioneer dealer.

You'll find it hard to believe such a little thing could come out sounding so big.

CT-F9191 Specifications:

Frequency Response: Standard, LH tape: 25-16,000 Hz (35-13,000 Hz ±3dB); CRO_2 type tape: 20-17,000 Hz (30-14,000 Hz ±3dB)

Signal-to-Noise Ratio: Dolby OFF: More than 52dB: Dolby ON: More than 62 dB (Over 5,000 Hz, Standard and LH tapes/When chromium type tape is used, signal-to-noise ratio is further improved by 4.5dB over 5kHz)

Harmonic Distortion: No more than 1.7% (OdB)

Wow and Flutter: No more than 0.07% (WRMS)

Motor: Electronically-controlled DC motor (built-in generator) x 1; (4.8 cm/s speed drive), DC torque motor x 1; (Fast forward and rewind drive)

U.S. Pioneer Electronics Corp., 85 Oxford Drive, Moonachie, New Jersey 07074

PIONEER®
High Fidelity Components

CT-F9191

Imported pickups

—versatile and economical for work and sport

By JIM DUNNE
and RICH CEPPOS

Can you name last year's best-selling passenger vehicle? If you picked a car, any car, you're wrong, because the best-selling vehicle was the Chevrolet pickup truck. In the light-duty category, about 1.1 million pickups were sold last year, and about 20 percent of them were imported. A large number of imported pickups were purchased strictly for personal use as recreation vehicles or second-car substitutes, while relatively few were bought for any kind of serious work.

What makes these little trucks more attractive to buyers than four-seat small sedans, which cost about the same? And how do the imports compare with domestic pickups? To answer these two important questions, we tested all of the pickups currently imported, a group that includes the Ford Courier, Toyota Hilux, Datsun 620, Mazda B-1800, and Chevrolet Luv.

All five trucks are built in Japan, can carry about a half ton, have four-cylinder engines, are relatively

Continued

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars, and that other seemingly identical cars may vary in performance. Also, weather conditions vary from test period to test period. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Ford	Toyota	Datsun	Mazda	Chevrolet
Fuel economy	4	4	4	5	4
Acceleration	4	5	2	1	1
Braking	2	2	1	4	1
Handling	3	2	1	2	2
Maneuverability	5	5	3	3	4
Ride comfort	1	0	2	1	0
Quietness	0	0	0	0	0
Roominess	3	1	4	3	1
Visibility	5	5	5	5	5
Entry/exit ease	5	5	5	5	5

Imported test trucks each had a unique quality. Clockwise, from top: Chevy Luv had ¾-ton payload capacity, making it best for heavy work. Mazda B-1800 is super economical, gets 40 mpg. Ford Courier was best-handling truck and best all around. Datsun was the best-riding truck, and benefited from extra room in its stretched cab. Toyota handled like a sports car on the road, and was also the quickest and quietest.

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KING, 100's: 19 mg. "tar", 1.2 mg. nicotine av. per cigarette, FTC Report DEC. '76.

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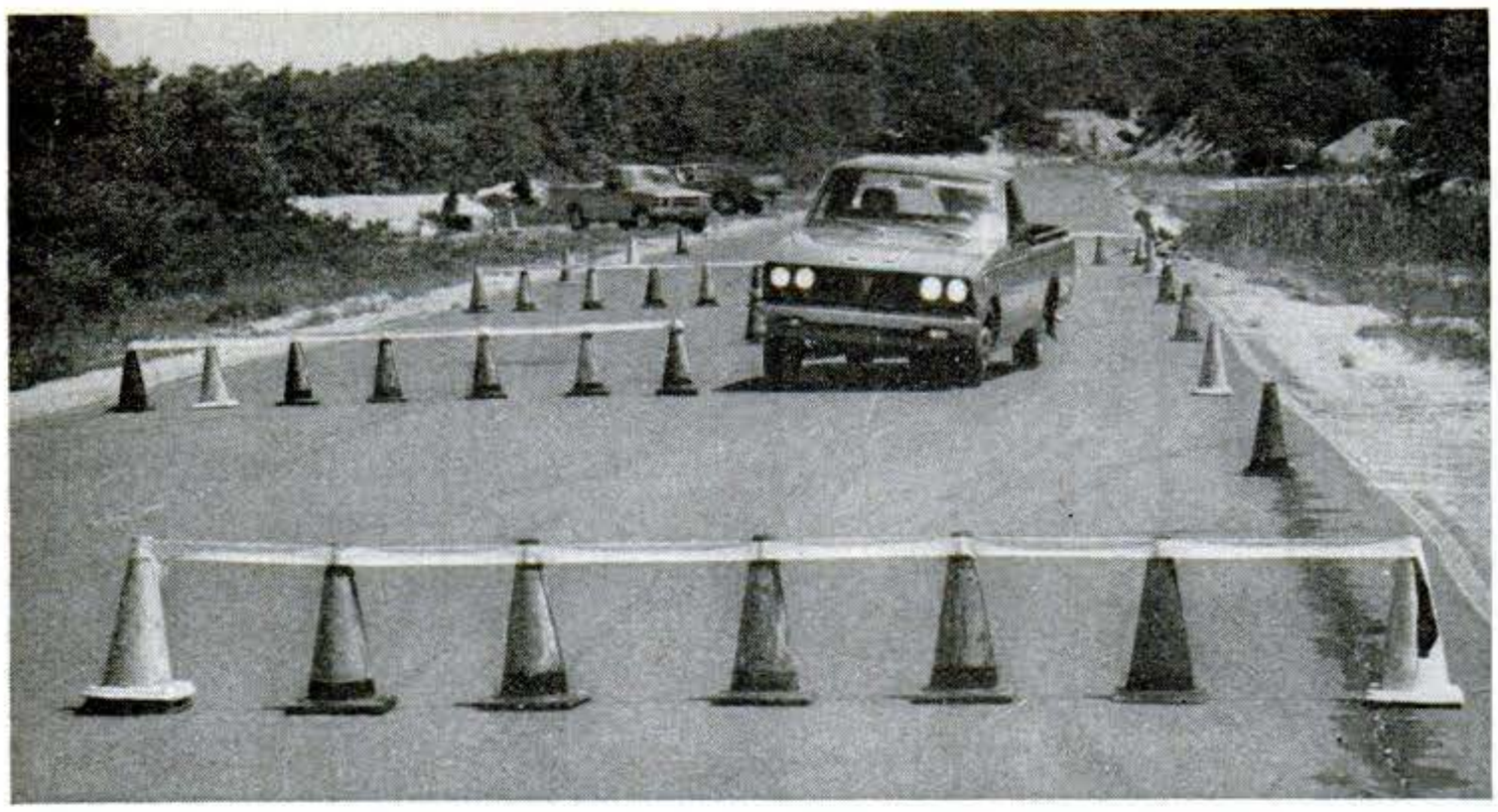
Winston King. Winston 100's.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.



Toyota (top) was surefooted in hard cornering, but hung its tail out like all the pickups (except Courier) when pushed hard. Luv (above) exhibits premature rear-brake locking that stretched stopping distances. Mazda, however, stopped perfectly with hot brakes.

Courier negotiates low-speed maneuverability slalom. Imported pickups proved agile in tight city driving due to light weight and compact size.

light and compact, and get excellent fuel economy. But in spite of similar specifications, they have surprisingly different personalities, and exhibit widely varying degrees of competence in any given area.

The Courier, built for Ford by Mazda, proved the best all-around truck in the group. It was the quickest through both handling tests, second to the Datsun in ride, and second to the Mazda in braking.

In the high-speed emergency lane change, the Ford was the most stable and reassuring, exhibiting none of the strong oversteer (tail-end sliding) of the other trucks. The Courier's optional 2.3-liter Pinto engine and optional five-speed overdrive transmission pulled it to 60 mph in 15.4 seconds, performance enough to keep it ahead of traffic in any situation.

Fuel economy of the Ford was excellent, with an EPA rating of 35 mpg highway, 25 city. And if you really want to pinch pennies, the standard 1.8-liter engine coupled to the five-speed transmission will deliver 41 mpg on the highway. By comparison, the best any domestic pickup can do is only 26 highway, 19 city.

The cab is roomy, with plenty of leg room for six-foot drivers, but the finish of the highline XLT interior could be improved. The molded-

EPA fuel mileage (mpg)

	Ford	Toyota	Datsun	Mazda	Chevrolet
Highway	35	34	32	40	33
City	25	24	22	28	23
California (highway)	34	33	30	35	32
California (city)	25	23	21	27	21

plastic instrument cluster looks crudely formed and the wood-grain contact paper was already peeling off the dash. And, like the other test trucks, the Courier was very noisy. In fact, these pickups are as noisy at 30 mph as American sedans are at 60 mph.

The Courier's brakes proved relatively effective compared to the other pickups but only average for an automobile. The Courier suffered from the same brake malady as the other trucks: premature rear-wheel lockup, a result of the brake system being calibrated for a full load.

Another characteristic the Courier shared with the rest of the test trucks was a poor ride. The harshness is a result of the stiff rear springs needed to safely carry a ½-ton payload. (Payload is the combined weight of passengers and cargo.) Realizing that a large percentage of pickup owners never use all of that carrying capacity, manufacturers are beginning to offer "soft-ride" packages. Our Courier had one, but the ride over rough city streets was still uncomfortable at best. To smooth out the ride, you must soften the springs—and sacrifice carrying capacity. In the case of the Courier, payload capacity was reduced from 1400 lbs. to just 900 lbs. Add two passengers and you're down to only 600 lbs.—not much for a working truck, but certainly adequate for personal use.

The Toyota was the quickest and quietest of the trucks and had excellent road manners. It was stable in a straight line, and surprisingly surefooted in corners. The torquey engine pulled the SR5 to 60 mph in only 14.7 seconds, faster than many sedans. The handling and power, in concert with the slick-shifting five-speed transmission, made the Toyota lots of fun to drive. But driving for long periods of time was uncomfortable; the ride is harsh and the cab cramped for anyone over five-feet-ten. The long-bed option adds an extra foot of space

Continued

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The Community College of the Air Force now has the authority to grant 2-year Associate Degrees.

It's a golden opportunity.

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AIR FORCE-A GREAT WAY OF LIFE

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Test trucks' spares are all secured by chain-and-ratchet mechanism. To remove spare, you insert crank into ratchet and unwind. Spare is lowered to ground.

to the SR5's six-foot bed, but does not increase payload capacity.

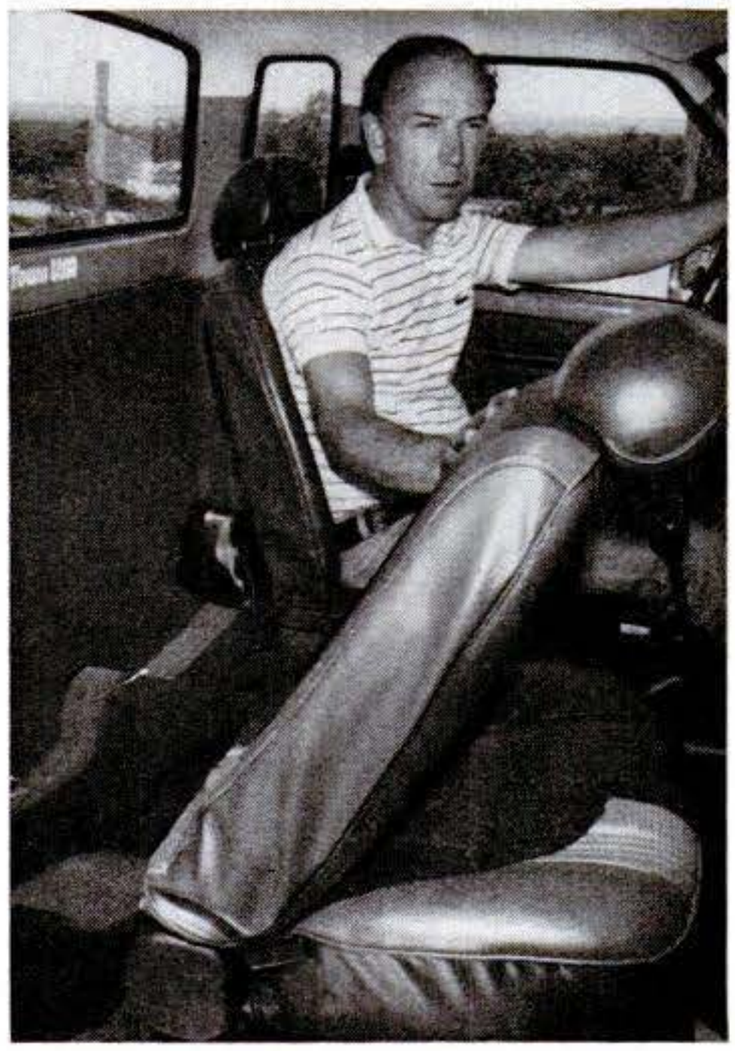
If ride and interior room are your primary concerns, then the Datsun King Cab should be your first choice. It doesn't ride as well as a subcompact car, but it comes closest of any of the test trucks. The handling, however, was the worst. The Datsun was prone to heavy oversteer when pushed to its limit. Its dismal braking performance was due to early locking of the front right brake, a problem we're sure was unique to the particular truck we tested.

The interior, however, has no such deficiencies. The King Cab is currently the only stretched-cab pickup offered in the imported market. The standard Datsun cab was stretched 9.5 inches, yielding 11.3 cubic feet of cargo space behind the front seats, which is very convenient for storing valuables. The vinyl interior is attractive and sturdy-looking, and the stretched cab provides ample leg room for six-footers. The truck's only really annoying feature is the transmission. It takes a lot of concentration to shift from fifth to fourth without grinding reverse in the process.

Mazda shares its body with the Courier, but its interior and drive-line are unique. Gone is the rotary engine and in its place is a miserly 1800-cc piston unit that delivers 40 mpg on the highway. But the Mazda gives away a lot of acceleration to get that extra mileage. It's also much noisier than the Courier, but has a better-finished interior. Ride and handling of the two trucks are very similar, but the Mazda, without radials, didn't handle as well. In braking, however, the B-1800 was far above the rest of our test trucks.

The Luv proved a disappointment. It was slow, very harsh riding, cramped, and noisy. The harsh ride can be traced to the Luv's payload capacity: 1500 pounds, which is 400 pounds more than that of any of the other trucks. That boosts the Luv into the ¾-ton category, making it suitable for heavy work.

How do the imported half-tonners compare with the domestic trucks? Very favorably. The imports are more compact and maneuverable. In a domestic pickup you tower over traffic and are conscious of driving something much bulkier than a full-size sedan. In an import, you almost feel as if you are driving a subcompact car. The imports' compact dimensions also make them easier to maneuver, especially in tight city traffic.



Datsun King Cab is stretched 9.5 in. It provides 11.3 cu. ft. of protected cargo space behind the seats and enough leg room for six-foot drivers.

Serviceability ratings

How easy is it to service our test cars? For example, is that heater hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

	Ford	Toyota	Datsun	Mazda	Chevrolet
Checking fluid levels:					
Battery	4	4	4	4	4
Master cylinder	5	5	5	5	5
Windshield washer	5	5	5	5	5
Engine oil	4	5	5	4	4
Coolant	3	5	3	3	3
Checking engine:					
Spark plugs	3	5	4	5	4
Distributor	3	5	3	5	4
Carb adjustment	3	3	3	3	3
Oil filter	3	4	4	4	4
Oil fill	5	5	5	5	4
Replacing hoses:					
Top radiator hose	4	5	4	4	4
Lower radiator hose	3	5	3	4	3
Heater hoses	3	2	3	2	2
Changing bulbs:					
Headlights	3	3	3	3	3
Taillights	2	3	5	2	2
Front running lights	5	2	5	5	5
Front parking lights	5	5	5	5	5
Front directionals	5	5	5	5	5
Rear directionals	2	3	5	2	2
Rear running lights	2	5	5	2	2
Checking fuses	5	5	5	5	5
Spare-tire accessibility	2	2	2	2	2
Changing belts	4	4	2	4	4

The imports' compactness means less interior room, though. Our test trucks could carry only two comfortably, while any domestic pickup can accommodate three passengers easily.

Nor can the imports match the domestics' choice of options such

Continued

Performance comparison with selected 1977 and earlier models

	1972 Chevrolet Luv	1972 Datsun 620	1972 Ford Courier	1972 Toyota Hi-Lux	1977 Dodge Aspen V8	1977 Pacer 6	1977 Ford Fiesta 4	1977 Chevy Chevette 4	1972 Chevrolet Pickup V8	1972 Ford Pickup V8
Mpg (city driving)	20	24	20	23	15	17	33	36	10	10
Accel. 0-60 mph (sec.)	21.4	25.0	21.3	18.3	14.6	15.2	15.3	19.9	13.4	15.0
Brakes 60-0 mph (ft.)	149	134	140	185	178	174	136	171	162	178
Handling (mph)	58.2	59.4	58.2	49.9	53.0	56.0	62.4	60.0	56.3	54.5
Maneuverability (mph)	29.1	28.1	27.2	25.7	23.9	24.6	31.1	29.6	25.7	25.0
Noise @ 60 mph (dBA)	79	76	78	78	70	69	72	74	74	74

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'78 FORD PICKUPS. TOUGH ALL OVER.

A new Ford Pickup is built tough from the ground up. Ford's exclusive forged steel Twin-I-Beam, extensive corrosion protection, big-cube V-8 options, all-welded cab, and double-wall box are just a few of the reasons.

But what makes a new Ford even tougher to beat are this year's new options like • Synchromesh 4-speed overdrive transmission for highway driving (not available on F-350 models) • Good-looking, comfortable new Lariat interior • 40-channel CB with concealed transceiver, single AM/FM/CB antenna, and all controls in the removable mike • New tilt steering wheel for your most comfortable position.

Take a look at all the new Fords. You'll find them tough all over. And *more* than just tough.

Built Ford Tough

93 out of 100 of all Ford Trucks registered over the last 12 years are still on the job.
(Percentage based on cumulative total registrations as of 7/1/76.)

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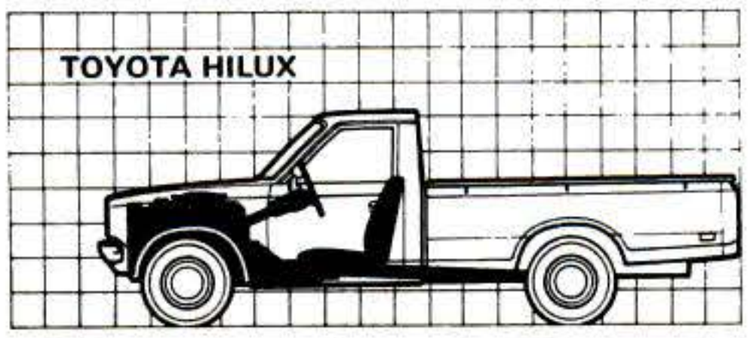

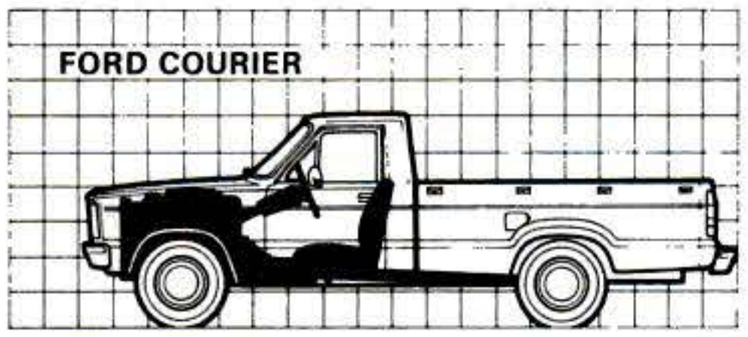

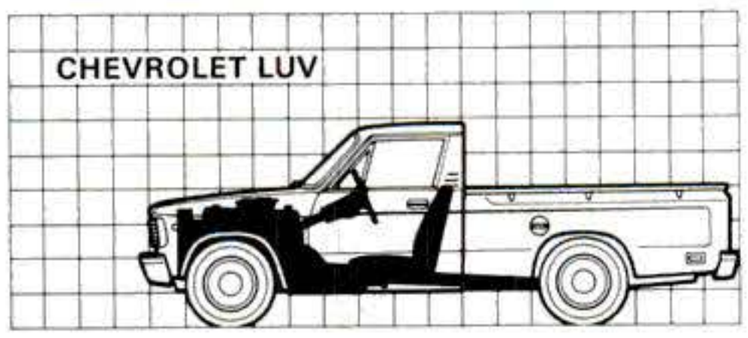

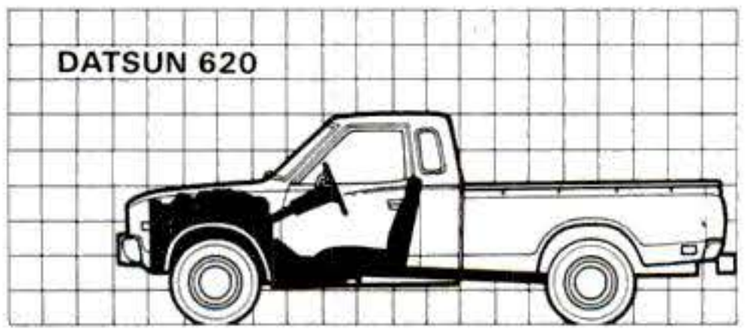

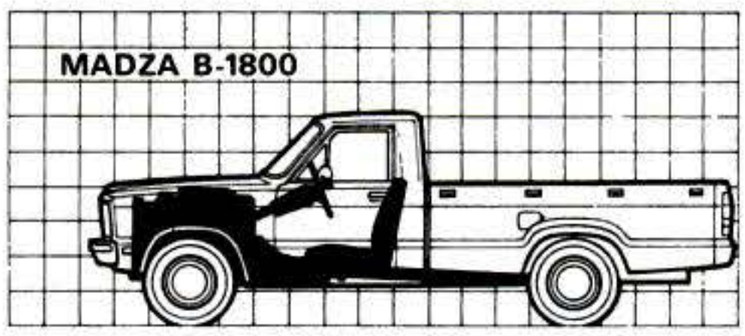

as power door locks, cruise control, power windows, and power steering. But they do offer the essentials, such as automatic transmissions, stripe-tape dress-up packages, air conditioning, and stereo radios.

What small pickups sacrifice in size and options they make up for in purchase price and fuel economy. The $3675 base price of the Ford Courier, for example, is about $300 less than that of the Ford F-100. And the more options you add, the wider the gap gets.

But no matter what advantages the imports may possess over the domestics, why so many people would opt for one over a small sedan still baffles us. Though the imports are closer to cars than the domestics, they still never let you forget they're trucks. On bumpy city streets you must wear the seat belts to keep from being bounced off the seat; the noise assaults your ears; handling and maneuverability are at the lower end of the small-car spectrum; and, except for the Datsun, any packages or luggage you have must ride in the open bed.

Imported pickups— specs, dimensions, and test results

	FORD COURIER	TOYOTA SR5	DATSUN 620	MAZDA B-1800	CHEVROLET LUV
DIMENSIONS (inches)					
Wheelbase	112.8	110.0	110.0	113.0	102.4
Overall length	189.4	184.6	178.7	187.0	173.8
Overall height	61.5	61.2	60.8	61.0	59.3
Overall width	63.0	62.2	62.6	63.0	63.0
Track, F/R	51.2/51.2	52.2/50.8	49.6/50.8	51.0/51.0	54.0/52.2
Ground clearance	6.7	6.5	8.4	8.0	7.5
Front head room	38.2	36.5	35.5	37.0	38.0
Front hip room	53.5	54.0	53.0	53.5	52.9
Front leg room	40.3	41.0	42.5	42.5	37.7
Cargo box (in.)					
Length	84	84	72	84	72
Width	62	56.3	60	62	62
Height	26	26.1	24	28	24
SPECIFICATIONS					
Engine type	OHC 4	OHV 4	OHC 4	OHC 4	L4
Displacement (cu. in./cc)	140/2300	133.6/2189	119.1/1952	109.6/1796	110.8/1817
Compression ratio	8.6:1	8.4:1	8.5:1	8.6:1	8.5:1
Carburetion	2 bbl.	2 bbl.	2 bbl.	2 bbl.	2 bbl.
Net hp @ rpm	77 @ 5000	95 @ 4800	97 @ 5600	67 @ 4500	80 @ 4800
Net torque @ rpm	102 @ 3000	122 @ 2800	112 @ 3600	92 @ 3000	95 @ 3000
Transmission	5-speed manual	5-speed manual	5-speed manual	4-speed manual	4-speed manual
Axle ratio	3.64:1	4.11:1	4.38:1	3.636:1	4.10:1
Tire make	Bridgestone	Bridgestone	Toyo	Bridgestone	B.F. Goodrich
Tire type	Radial	RD105	Light truck	Light truck	Belted
Tire size	195SRx14	185SRx14	6.00x14	6.00x14 LT	E78x14
Steering	Manual; variable ratio	Recirculating ball; manual; variable ratio	Manual	Manual; variable ratio	Recirculating ball; manual
Overall steering ratio	18-20:1	19.5-23.5:1	19.8:1	18-20:1	17.8:1
Turns, lock to lock	4.1	4.6	4.25	4.1	4.25
Turn diameter (ft.)	41.3	42.7	39.4	39.0	34.7
Front suspension	Independent w/ coil springs, stabilizer bar	Independent w coil springs, stabilizer bar	Independent torsion bars with stabilizer bar	Independent coil spring	Independent, torsion bar springs, w/stabilizer bar
Rear suspension	6-leaf progressive-rate semi-elliptic springs	Semi-elliptic leaf springs	Semi-elliptic leaf springs	Semi-elliptic leaf springs	Semi-elliptic main and auxiliary leaf springs
Brake type	Power disk drum	Power disk drum	Power disk/drum	Power disk drum	Power disk drum
Brake swept area (sq. in.)	n.a.	351.8	226	314	286
Fuel tank (gal.)	17.5	16.1	11.9	17.4	13.2
Curb weight (lbs.)	2675	2550	2495	2605	2460
F/R weight distribution (%)	56/44	57/43	57/43	56/44	55/45
Gross payload capacity	900	1100	1100	n.a.	1510
Basic price	$3676	$3857	$3799	n.a.	$3394
Price as tested	$4146	$4402	$4891	n.a.	$4081
Options on test vehicle	XLT pkg. ($314), WSW radials ($121), 5-speed trans. ($146), AM/FM ($135), tinted glass ($25), 2.3-liter motor ($153)	SR5 longbed 5-speed ($524), weatherguard ($21)	King Cab ($400), 5-speed trans. ($150), A/C ($440), AM/FM ($102)	None	Mikado pkg. ($253), WSW tires ($34), AM/FM ($135), striping ($90), chrome rear bumper ($60), misc. ($115)
TEST RESULTS					
Acceleration 0-60 mph (sec.)	15.4	14.7	19.7	21.2	21.5
Acceleration 25-70 mph (sec.)	15.6	17.6	22.2	30.0	25.9
Brake test (cool) 60-0 mph					
Stopping distance (ft.)	145	137	245	182	214
Pedal pressure (lbs.)	84	80	80	65	80
Disk temperature (°F)	128	132	132	127	135
Brake test (hot) 60-0 mph					
Stopping distance (ft.)	169	180	208	135	203
Pedal pressure (lbs.)	100	120	80	85	85
Disk temperature (°F)	548	530	590	585	535
Interior noise @ 60 mph (dBA)	75	73	76	77	76
Handling test (mph)	60	58.2	53	56.3	58.2
Maneuverability (mph)	29.6	27.6	25.7	25.7	26.8

If you have a real need for a ½-ton pickup, the imports offer an economical alternative to domestic pickups. But if you are thinking of buying an imported pickup, but have no plans to put it to work, we'd suggest considering a small car instead. PS

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Carb problem

My problem is with the carburetor on my 1976 VW Rabbit. In cold weather the fast idle works fine and cuts off at a water temperature of 160° F. In warm weather I have to keep my foot on the gas to keep the engine from stalling at water temperatures of 100°-140° F. Once the car warms up to 160° water temperature, the engine idles fine.

The dealer has worked on this three times and installed two new automatic chokes to no avail. Can you help?

Jack D. Lauber, Latham, N.Y.

Unfortunately, yours is a standard problem. '76 carbs are bad news. Increasing idle speed helps. And make sure the secondary isn't open too far on idle.

Talk to five more mechanics and you'll get five or 10 more fixes. I'd hate to tell you how many times we had to try to fix one after the local dealer fell on his nose with the factory's helpful hints. Our fix ended up as a little more fuel at idle, and a slight increase in idle speed.

Gasoline questions

I have two questions:

1. If lead is an additive to gasoline, why do motorists have to pay more for unleaded gas than regular gas?

2. If a loaded tractor trailer weighing 80,000 lbs. gets four miles to the gallon, and a 5000-lb. automobile gets 16 miles to a gallon, what is the efficiency ratio in gallons of fuel consumed? I realize that we are comparing two different fuels.

Harold J. Magruder, Hyattsville, Md.

I don't knock the fuel companies, because in my opinion one of the biggest bargains in the U.S. is the price of fuel (less taxes). But as far as I'm concerned there is no reason why unleaded gas should be priced differently than leaded fuel.

Your second question would take a book to answer. But I get what you're driving at. If you're ready to squeeze up in a 1800-lb. car with 75 hp you'll get economic relief. All things considered, there are no giant mistakes in cars. Our problems are from uninformed, gutless, crooked politicians and a car-manufacturing industry with a policy that's dictated by sales instead of engineering, and a buying public that gullibly buys all the double-meaning advertising year after year and still hasn't reared up on its hind legs and said, "I'm tired of the baloney. I want sensible surface transportation that I can be safe in, can afford, and that's suited to the times and the economy I have to live with."

What about additives?

Could you please give me some guidance regarding oil additives in a 1968 six-cylinder Ford engine, and in a 1968 six-cylinder Valiant engine? Is an additive of any value?

George A. Gillies, Berkeley, Calif.

I answer your question because it's asked so many times. Mineral-based oil made from crude oil has three big problems. One, its borderline ability to handle temperatures reached in heavy, hot service. Second is its short ability to handle high unit loading (for example, cam lobes). Third, its character and viscosity changes when heated by temperature and pressure.

This is true of all makes with a mineral base. So oil producers (and I'm talking about the best brands) add much chemistry to try to solve these shortcomings. But the chemistry won't stay put. I've seen thousands of oil improvers and oil fixes in the last 30 years, but I don't know of any that work across the board in all conditions.

And remember this: If you have just bought a new car and intend to use one of the new additives, the manufacturer will tell you 99 times out of 100 that your warranty will no longer apply.

Black-box trouble?

I have a 1974 Ford LTD four-door Brougham 400 with only 6000 miles. Recently, during highway driving, the car stopped cold after going about 10 miles. I put the transmission in neutral and coasted off the road. I checked under the hood, but could see or smell nothing unusual. I got back in the car and had no problem starting it.

This happened two more times on a 25-mile trip. I had no trouble on the return trip.

Next day I went to a garage mechanic and told him about it. He changed a few things: a new air filter, new wire from distributor cap to coil, changed thermostat from 195° to 165°. Next day the same thing happened. I took the car back to where I bought it. They installed a new electronic-ignition box. So far, for two months, the car runs fine.

Two questions: What causes the electronic ignition to create this problem? Why is it necessary to run the engine so hot anyway?

Harvey Zuhlman, Gulfport, Fla.

Most electronic ignitions are transistorized and change in value above 150° F, so temperature can affect them. This could have been your problem. Heat buildup may have created an electrical leak or component malfunction. I'd say

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your trouble has been fixed. As for the 165° thermostat, it won't hurt anything. But I bet that you will get better mileage with the 195° thermostat. I'd put that back in.

Antifreeze or water?

Which will handle the highest heat load in an automobile cooling system—Prestone or plain water?

B. I. Stevens, Waterbury, Conn.

The longer I work on alternate energy the more I realize how useful, precious, simple, and taken for granted water is to man. The straight answer to your question is water.

Race-car cooling is a problem because engines produce maximum power. Weight and space are a problem. Cost is not a factor. I've tried every chemical magician's trick; I always end up back on water.

But that's not the whole story. Over the long haul, with a liquid-cooling system's chemical changes, reactions, and change of ambient temperature (+100°F down to −20°F), water can't do the job alone. So turn to the chemist, and—presto—Prestone or other chemically similar mixes do the job.

Hard starting

I have a 1975 Vega with automatic transmission and electronic ignition, and the car is hard to start when cold. (It has 15,000 miles on it.) I've had it tuned up several times, including an emission-control check by the Chevrolet dealer. This did not help. I have to pump the accelerator pedal 15 times in order to get it started at three above zero. Below zero I have to plug in the engine heater for at least a half hour in the morning to be sure it will start. What can be done?

Robert Hargrave, Minneapolis, Minn.

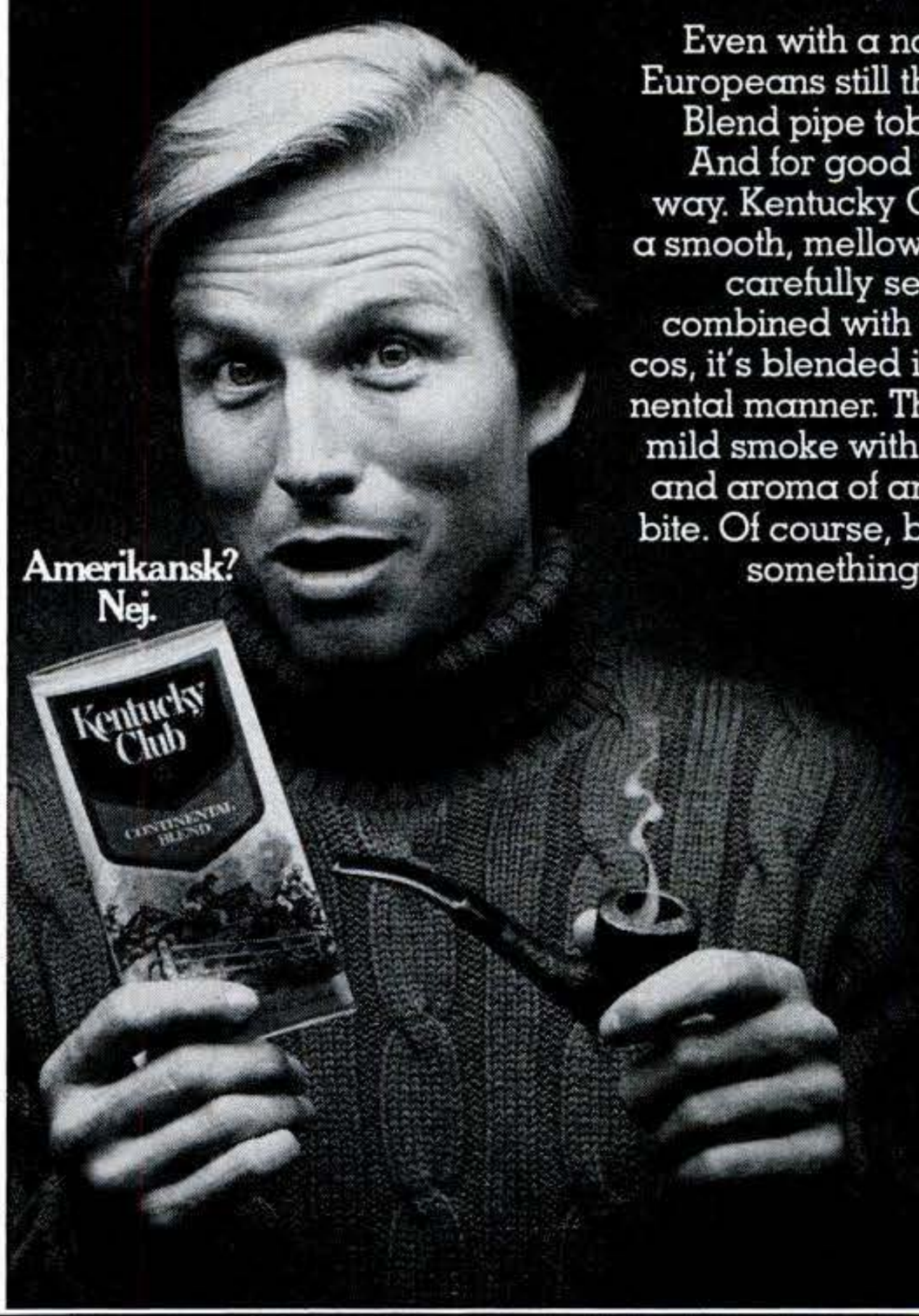
You are doing the most practical thing when you preheat the engine. A strong battery and larger battery cables are big pluses in cold starting. But with emission controls calling for lean mixtures, and the tremendous difference in the behavior of gasoline at 0° F compared to 60° F, proper vaporization of fuel for cold starts is hard to get.

With no preheating, big aids are special fuel (low vapor pressure), hot plugs, richer low-speed fuel flows, a tight choke, increased energy flow to the starter, and lightweight lubricants.

With modifications, preheating gives good starts, less fuel-oil dilution, and longer engine life, because warm oil gets up to pressure quicker than cold oil. PS

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" Popular Science, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

Introducing Kentucky Club Continental Blend. The tobacco Europeans refuse to believe is American.



Even with a name like Kentucky Club,® Europeans still think our new Continental Blend pipe tobacco is one of their own. And for good reason: We made it *their* way. Kentucky Club Continental Blend is a smooth, mellow Cavendish cut. Made of carefully selected air-cured burleys, combined with rich, ripe Virginia tobaccos, it's blended in the slow, age-old continental manner. The result is a remarkably mild smoke with all the full-bodied flavor and aroma of an import. And none of the bite. Of course, besides our name, there's something else that'll tell you we're not imported. Our price. New Kentucky Club Continental Blend. Compare it to whatever imported tobacco you're smoking now and we'll bet you'll never import your tobacco again.

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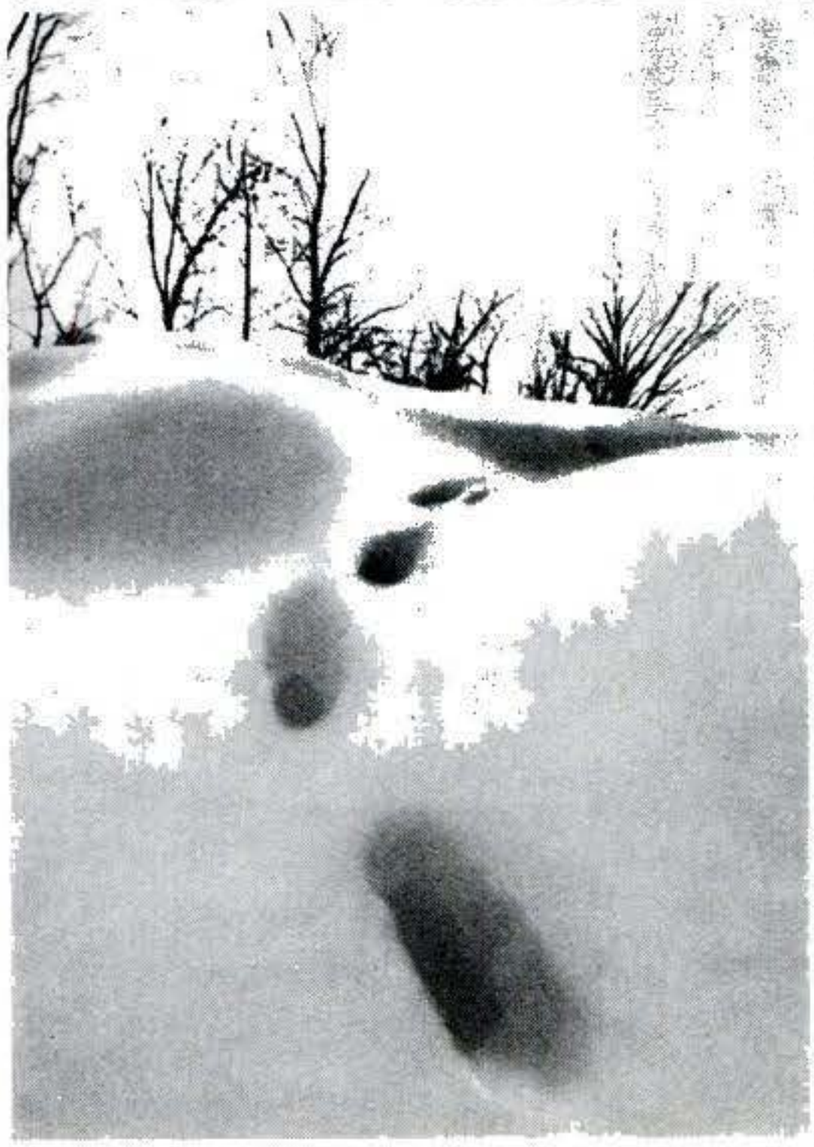

They used to be easy to spot.

But today's fashion trend has produced a whole new crop of boots designed to look like the ones we've been making in Maine since 1879.

So you'll have to look a little harder for the original quality, craftsmanship and never-say-die durability of Herman SURVIVORS®.

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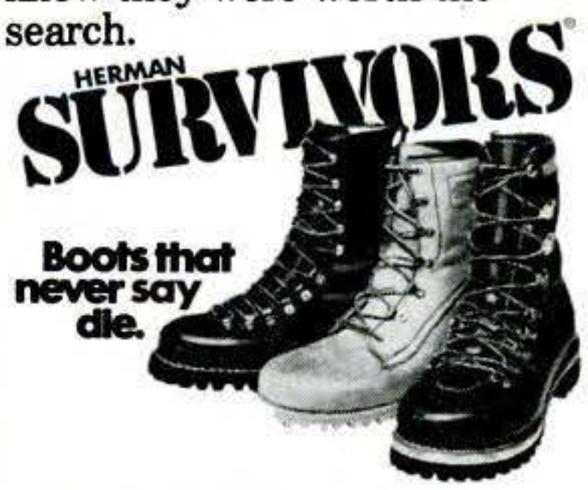

For our color catalog and location of stores near you, write Joseph M. Herman Shoe Co., Inc., Dept. 61, Millis, MA 02054.

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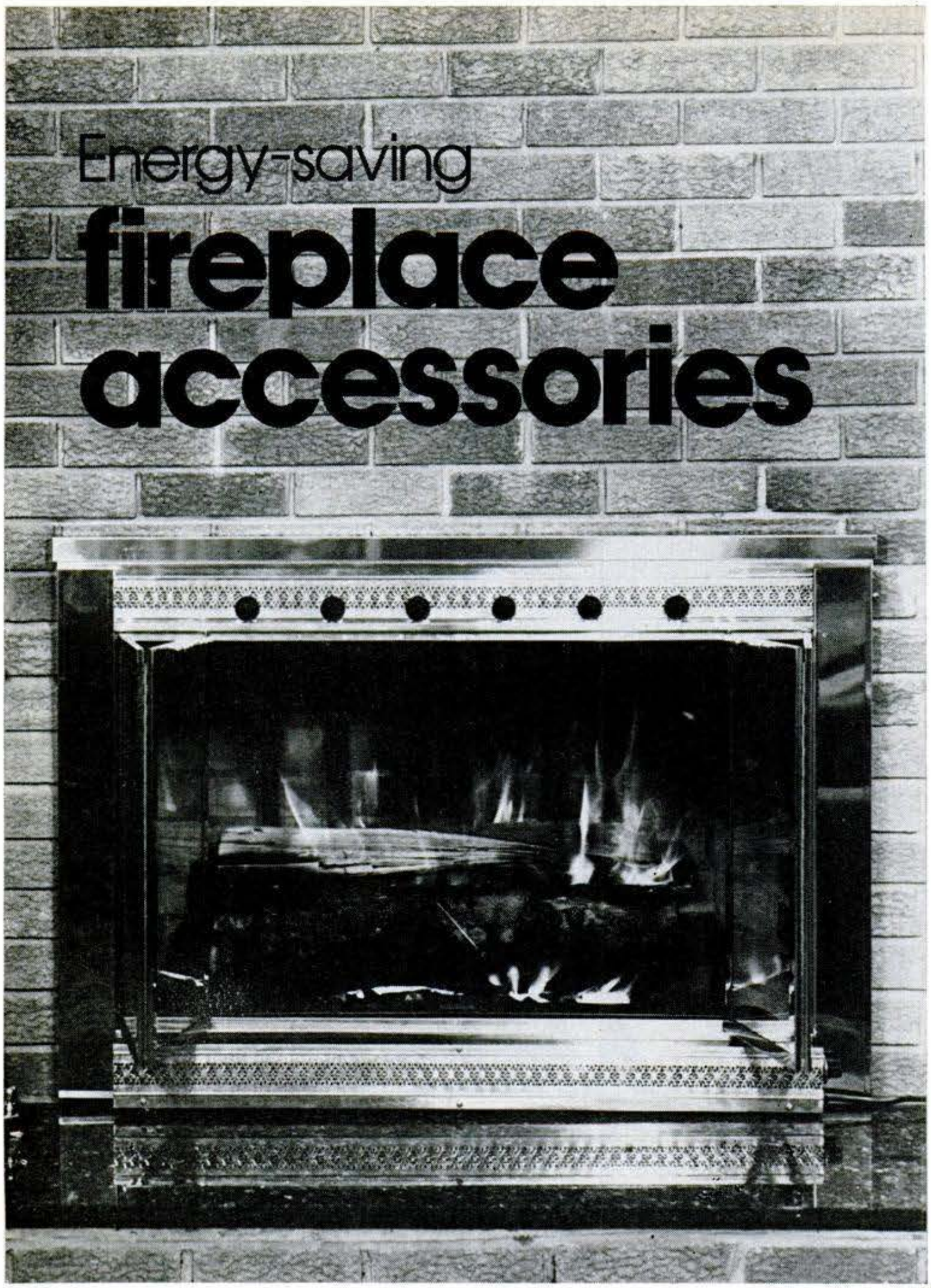
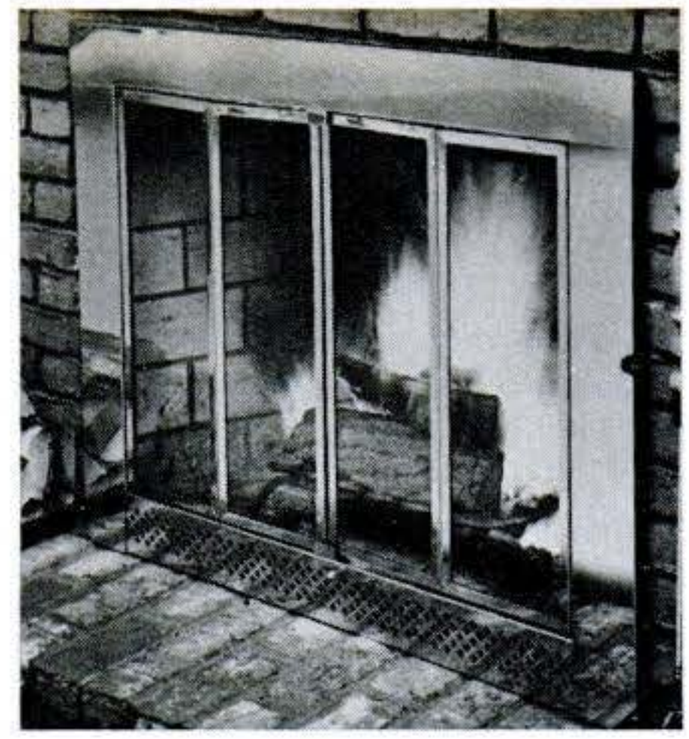
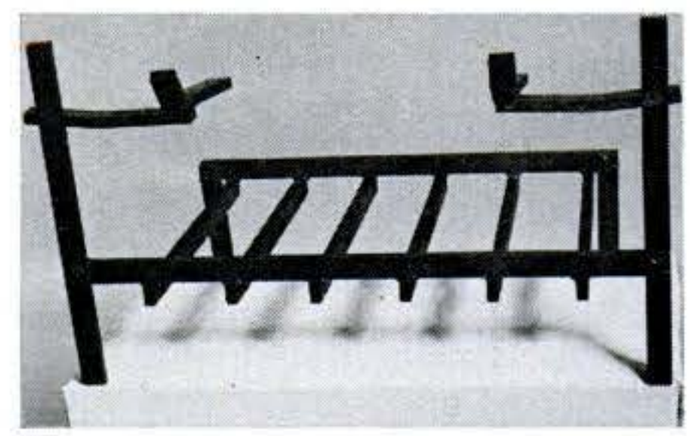
Energy-saving fireplace accessories



All rolled into one—warm-air blower, grate, heat-tempered glass in solid brass frames—that's Elegance I, available in five sizes from General Products. A 100-cfm blower is housed in the cool insulated base of the door frame. General also markets blowers separately under the Convect-O-Heater name, claiming up to 40,000 Btu of heat output. All models are 14-gauge tubular steel.



Fireplace enclosures can enhance both a fire's efficiency and a room's decor. These Custom-Fold doors from Heritage feature glass-wool insulation for a tight seal around irregular openings. Heat-tempered glass is standard in four-door (shown) and two-door models. They fold aside, too, for complete access to the fire. In nine sizes and three finishes.



Log arrangement is crucial for efficient fires, says physicist Lawrence Cranberg, who invented the Texas Fireframe, a 25-inch-wide (front), 15-inch-high hot-rolled-steel grate. By suspending a large upper log over smaller ones and over a back log, a slot-shaped opening is created, permitting all logs to burn slowly and evenly for better radiant heating, he says. $39.95.

By EDWARD MORAN

As we enter another winter uncertain over fuel, Americans continue to rediscover the fireplace. The industry estimates that by 1980, more than 60 percent of all American homes will have working fireplaces.

But the old-fashioned fireplace can be a notorious energy-waster. Do the crackling flames have to singe your side-whiskers before you feel mellow? If so, you might consider these easy-to-install accessories designed to increase the energy efficiency of the wood-burning process.

You'll find manufacturers' addresses listed at the end of this article. The Fireplace Institute (111 E. Wacker Dr., Chicago, Ill. 60601) offers helpful consumer information to those who want to return the fireplace to its rightful place in our thermocratic society, where the consumers of power control their energy destinies. PS

Turn the page for more accessories

Thriftchanger, from Sturges Heat Recovery, can be retrofitted or designed into new fireplaces. Heat exchanger shown at right in photo can be camouflaged in closet or basement; it traps heat normally lost up chimney by means of 64 vertical tubes. Ducts distribute heat as needed, and a water-heating coil is optional. Models are also available for wood stoves.

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Both blue jeans and Dodge pickups got their start by being tough. Dependable. And therefore necessary.

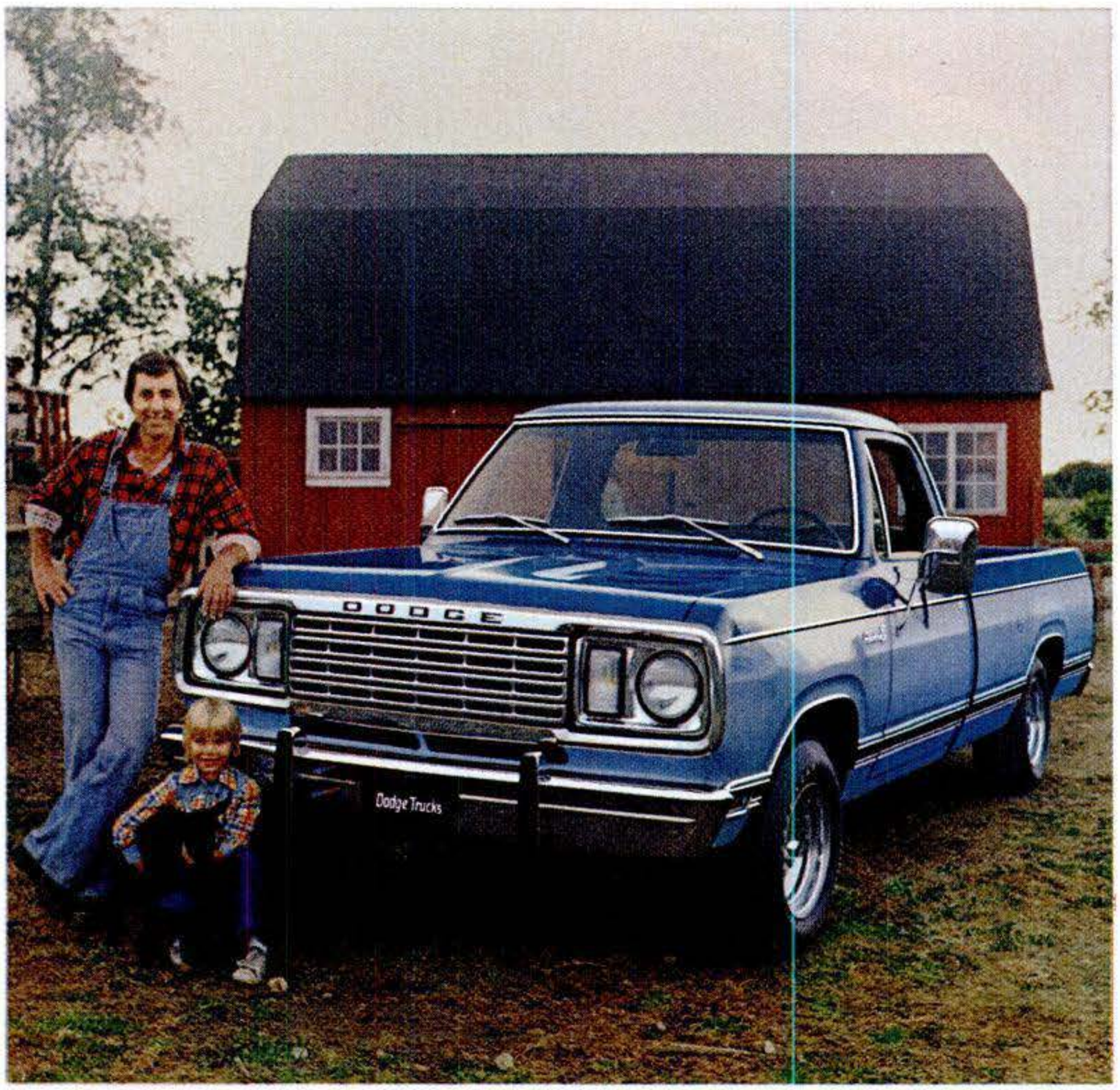
Then something happened. Jeans became a whole new style of dressing. A denim philosophy that captured the mood and attitude of an entire country.

And Dodge pickups stopped being just workhorses and found themselves as at home on the town's main drag as on a dusty country road.

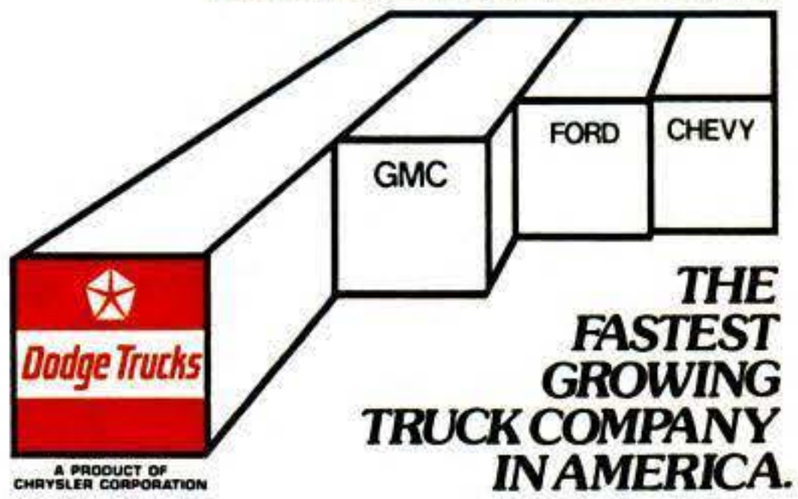
The plain Jane Dodge pickup has grown into pickups with Crew Cabs, Club Cabs, two- or four-wheel drive, dual rear wheels, and a variety of carrying capacities.

You can equip them with road wheels, white letter tires, bucket seats, stereos, air conditioning, and special paint jobs.

And you can take your choice of buying or leasing.



Dodge pickups have become an exciting part of America's new style. Get into it yourself... at your local Dodge Dealer's.



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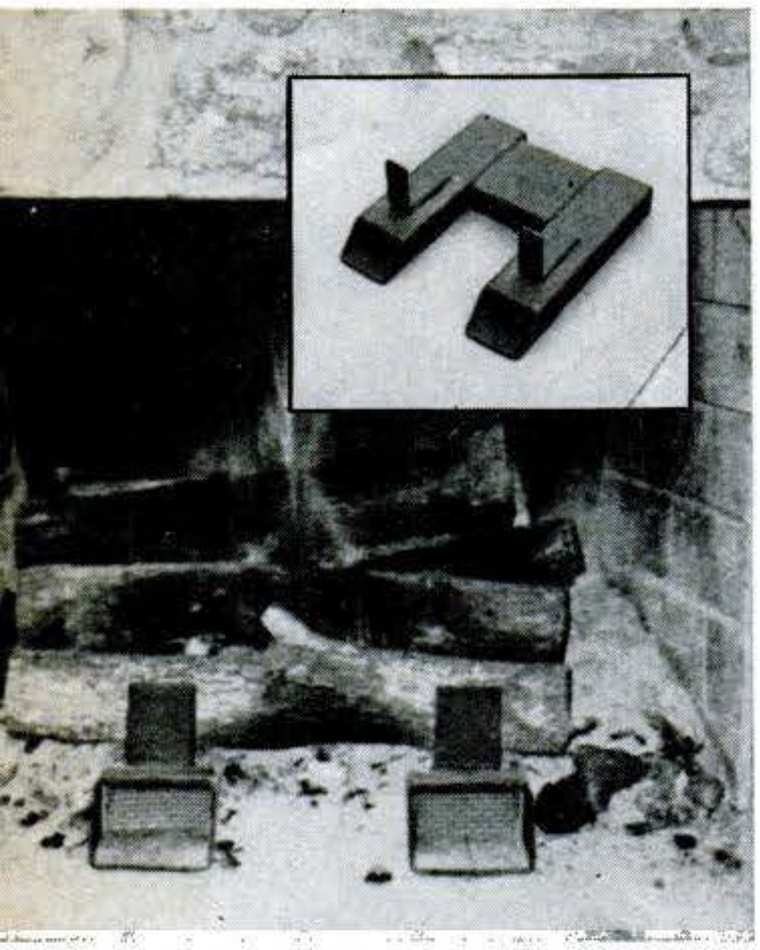
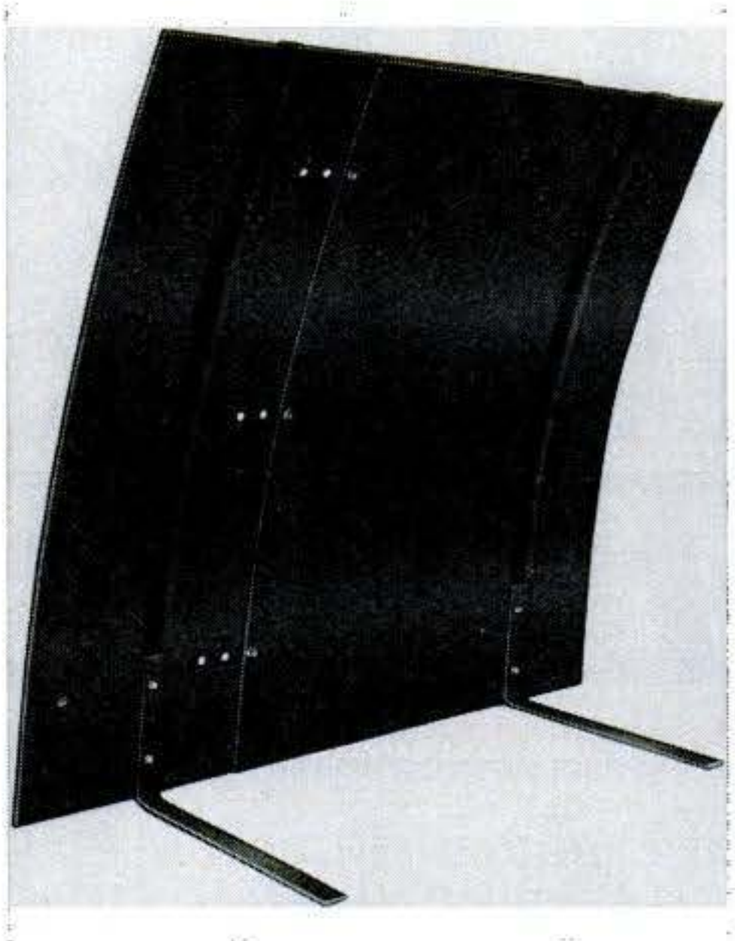
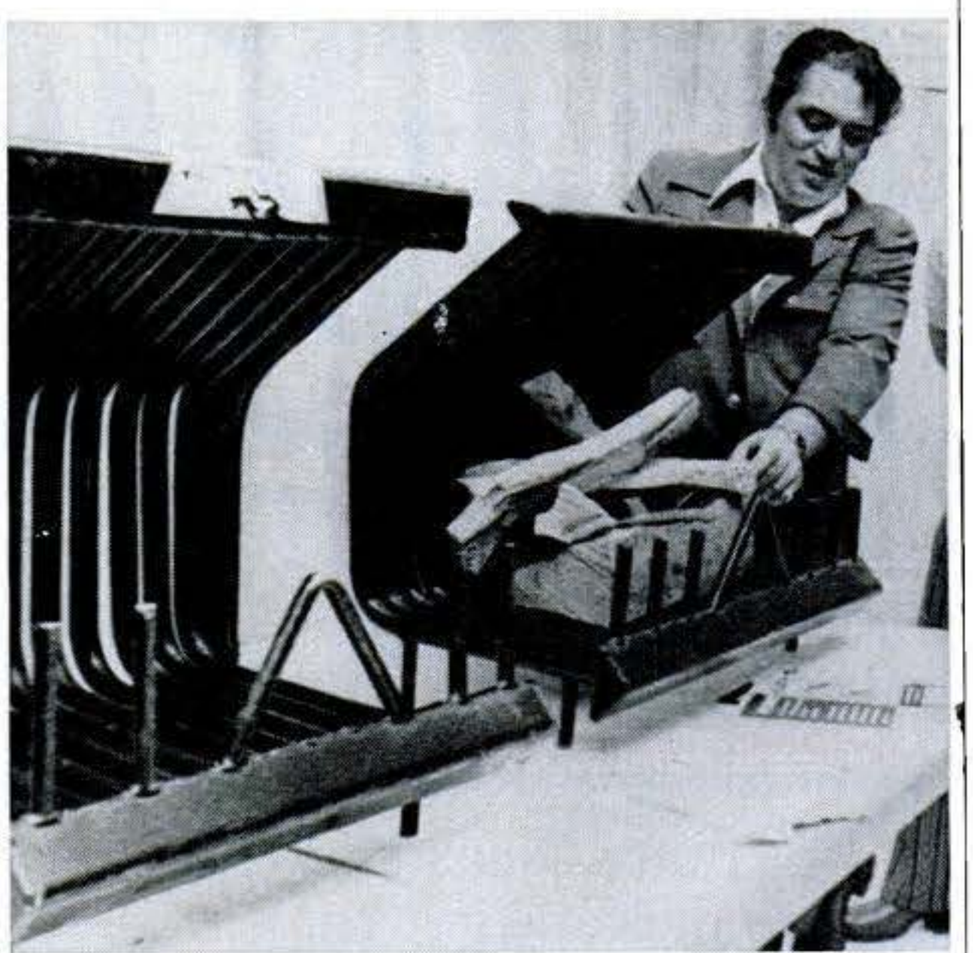


Outside air supplied to a fire—through the ashpit, through the back, or through the floor—can prevent warm room air from being drawn up the flue. Jai Ram's Air Iron and Air Hearth are designed to supply a large volume of combustion air directly to the hearth, reducing wood consumption, claims the maker. All units are custom-made of seam-welded 3/16" steel. From $59.



Assemble the Kronos Reflector with hex nuts and bolts (the overlapping panels allow you to size it to your own fireplace), then place it behind the fire to improve draft and reflect heat into the room. The black panels, made of rolled-rib, 22-gauge steel, can fit fireplaces 28 to 40 inches wide. A single panel can be used for smaller fireplaces (each panel is 18 by 28 inches). $29.95.



Tie your fireplace into your central heating system with Hydrohearth, a tubular steel device that preheats water or antifreeze solution to heat radiators or ducts (via a heat exchanger). Unit, which replaces the conventional grate, is available in four sizes with average outputs of from 30,000 to 50,000 Btuh, says Hydroheat, the maker. Unit is compatible with solar and heat pumps, too.

ON SALE OCT. 30—NOV. 26, 1977.

Comes partially assembled.

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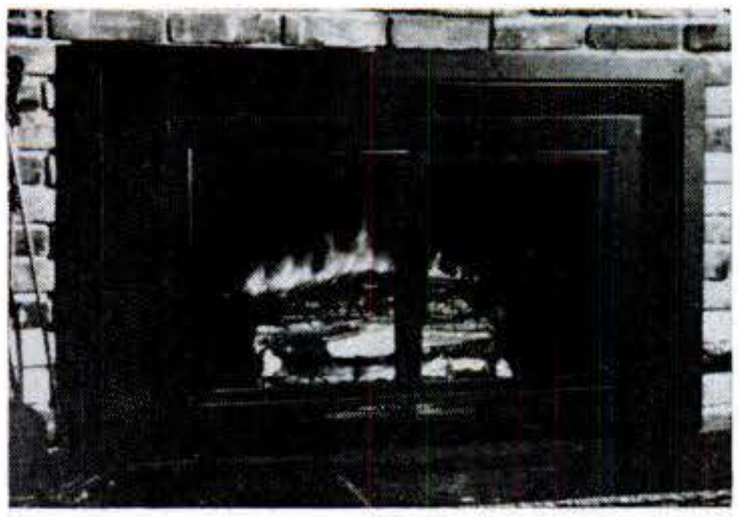
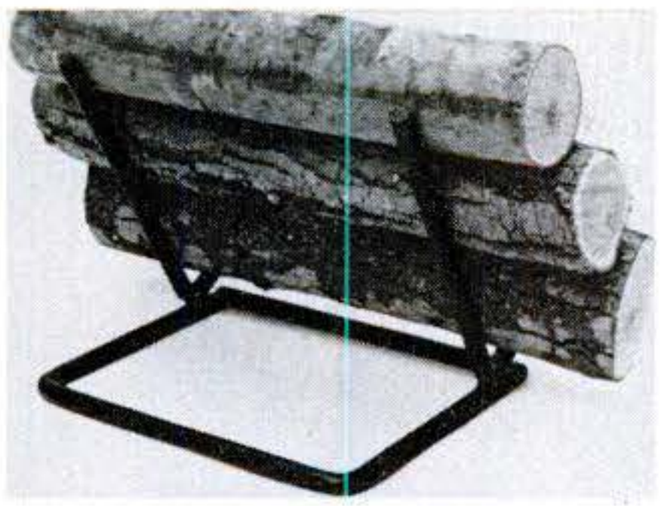
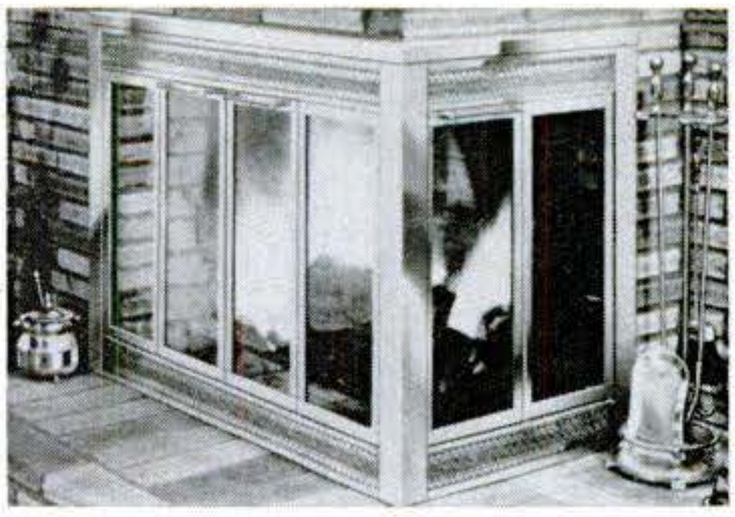


El Fuego's convector firebox, Fuego III, can be installed with common tools inside an existing fireplace. It's made of 12-gauge steel, comes in three sizes. With glass doors and grate, Fuego III is designed to permit fire to burn with damper nearly closed—the unit conducts and radiates heat back to room, claims maker. Frames, grillwork are included.



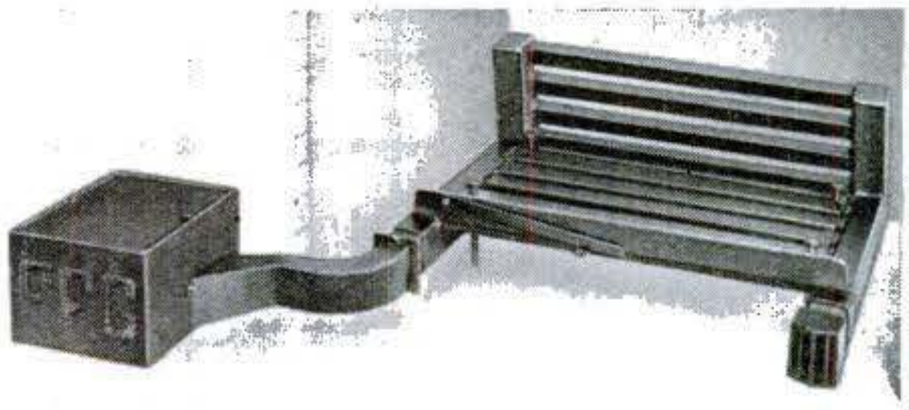
Kermco's Heat Booster holds firewood at an angle toward you, radiating more heat into room and less up chimney. To install, just place it on top of conventional grate or directly on fireplace floor, with long, angled rods facing the room. It's constructed of ⅝" round steel rod with heat-resistant black finish. The 12¼" x 10½" x 10⅝" unit is $17.95.



Screens help regulate airflow and damping. Glassfyre screens, from Portland Willamette, are offered in a variety of styles, including this corner model. Folding tempered-glass doors are in a metal frame that clamps permanently to the lintel. Close them (and the damper) at night to keep warm air from escaping up chimney.

Blower-assisted accessories
(more, overleaf)

Portable grate, Frahm's Heat-A-Thon, circulates warm air through your room by means of an electric blower (a thermostatically controlled automatic model is optional, as is a DC battery-powered model). The grate is fabricated of 11-gauge tubular steel. The blower filters cool air, feeds it into the grate tubes, then expels it as heated air. Heat-A-Thon comes in eight standard sizes and can be custom-built.



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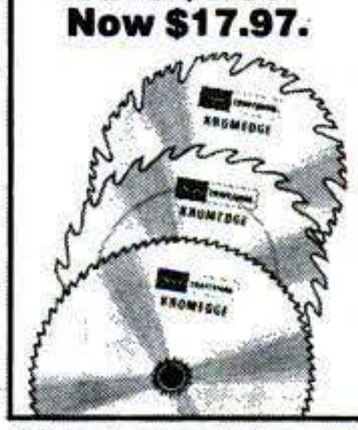	• 8-inch Sanding Wheel • 15-piece Molding Head Set • Taper Jig • 10-inch Hollow Ground Blade • 16-tooth Carbide-tipped Dado

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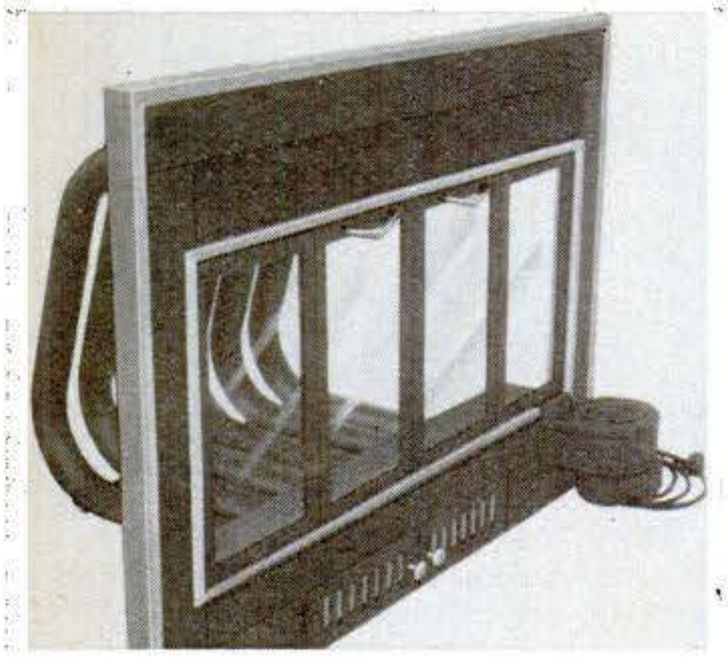
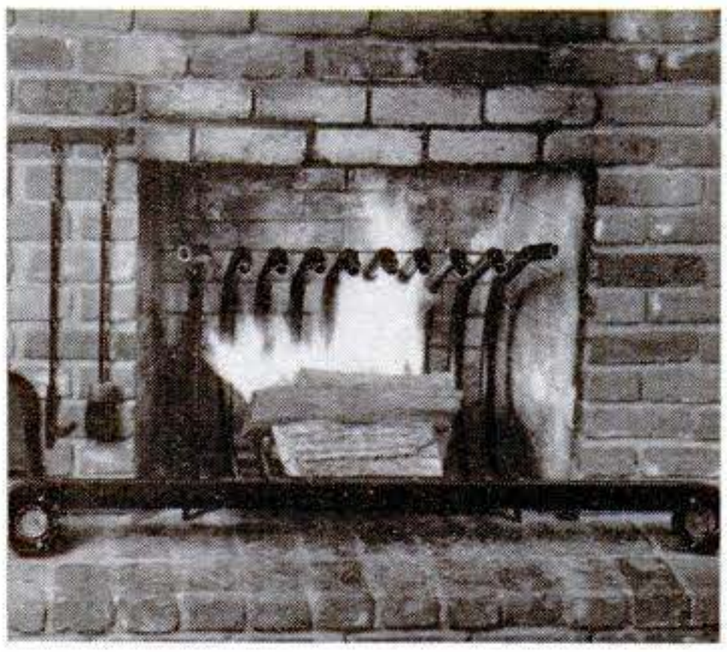
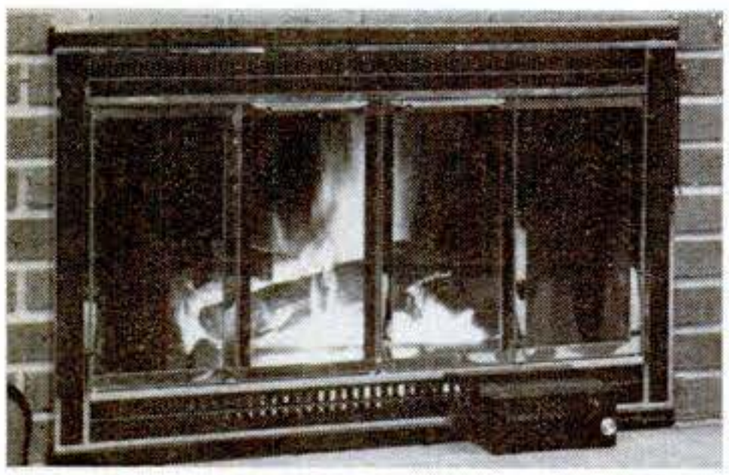


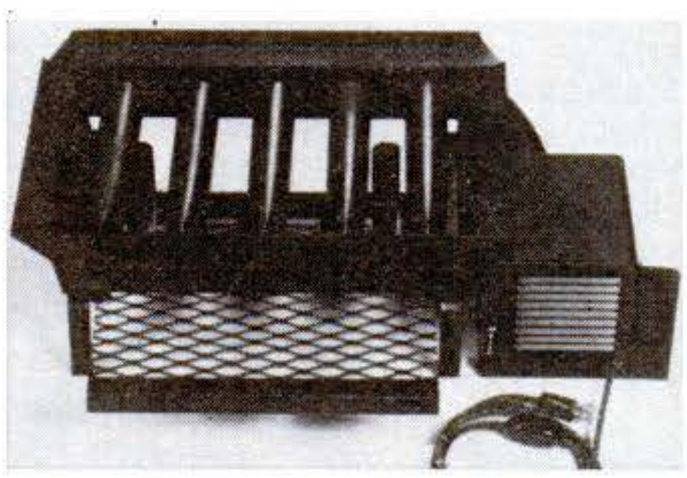
Glass Door Thermograte doubles as a fireplace closure and a tubular heat extractor. The C-shaped (in side view) unit sucks in cold air at bottom and expels warm air from top. Frame is of welded angle iron and steel bar; tubes are 16-gauge chrome nickel stainless steel. Thermal-expansion seals allow tubes to expand individually as they are heated. Forced-air blower is optional.



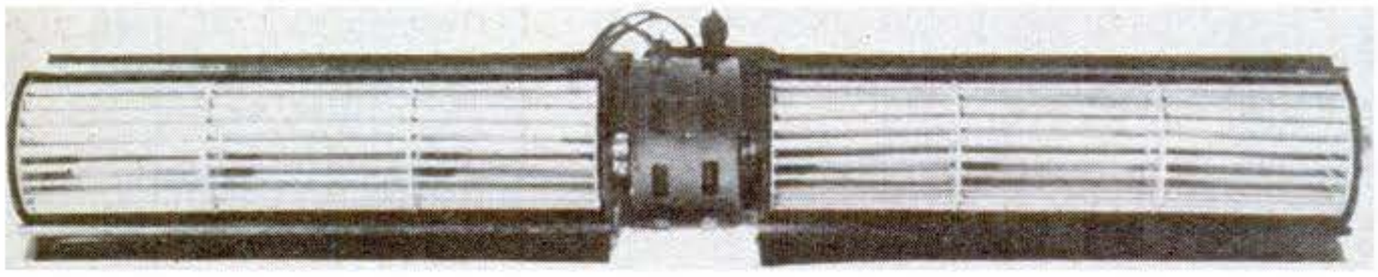
Woodmack's Heat-A-Grate comes in several sizes—with five, six, eight, or 10 tubes—ranging from $59.95 to $209.95. One or two power blowers (30 or 100 cfm) can be attached to the grates. Shown here: Concord model with two 30-cfm blowers. This top-of-the-line design features tubes curved downward to force heated air to room. All models are 13-gauge muffler steel.



Installed with glass doors, the Warm Hearth II converts your fireplace into a furnace, says Weathercock. An 80-cfm variable-speed blower (the little black box in photo) circulates air through a welded-steel duct beneath and behind the fire, then expels it via outlet at left. Unit adjusts in width from 32 to 52 inches, and is adjustable for depth, too. The blower assembly is removable.



Five heat-exchanger tubes support logs in Morton Metalcraft's Hearth Furnace. An expanded metal mesh beneath holds glowing coals. And a heavy-duty 60-cfm blower forces air through the hollow tubes (which are replaceable), delivering up to 40,000 Btuh into the room, claims the maker. The unit is 27 inches wide, 8½ inches high, and 16, 19, or 22 inches deep.



Preway's new blower can be used as an accessory on all its built-in fireplaces. Easily installed beneath the hearth, the transflow device accelerates air circulation to raise temperature of a room more rapidly in a shorter period of time, claims the manufacturer. It is not visible after installation. Suggested retail price for the BK165 is $91.80. Preway also makes fireplaces with built-in blowers.

WHERE TO GO FOR MORE INFORMATION

(Listings are alphabetized by manufacturer, not by model or brand; see captions.)

El Fuego Corp., P.O. Box 33, Oakville CT 06779; **Frahm Fireplace Grate Inc.,** 256 S. Pine St., Burlington WI 53105; **General Products Corp.,** 20 Railroad Ave., West Haven CT 06516; **Heritage Fireplace Equipment Co.,** 1874 Englewood Ave., Akron OH 44312; **Hydroheat,** Airport Center, 4250 Veterans Memorial Highway, Holbrook NY 11741; **Jai Ram, Inc.,** 7 All Souls Crescent, Biltmore Village, Asheville NC 28803; **Kermco Products,** Box 204, Monroe IA 50170; **Kronos Products Co.,** P.O. Box 23429, Louisville KY 40223; **Morton Metalcraft, Inc.,** Route 98 West, Morton IL 61550; **Portland Willamette Co.,** 6800 N.E. 59th Place, Portland OR 97218; **Preway, Inc.,** Wisconsin Rapids WI 54494; **Sturges Heat Recovery,** P.O. Box 397, Stone Ridge NY 12484; **Texas Fireframe Co.,** P.O. Box 3435, Austin TX 78764; **Thermograte Enterprises, Inc.,** 51 Iona Lane, St. Paul MN 55117; **Weathercock Industries, Inc.,** 1963 West Sixth, Eugene OR 97402; **Woodmack Products, Inc.,** 606 Charcot Ave., San Jose CA 95131.

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ON TARGET

By PAUL WAHL

New pump shotgun

With its bottom ejection, the new Browning BPS 12-gauge pump reminds me of the old Remington Model 17 produced 1921-1933 and the Model 37 that Ithaca has made for the past 40 years. All three share the same fine heritage—John M. Browning's 1915 slide-action shotgun patent. But the BPS has some dandy features of its own.

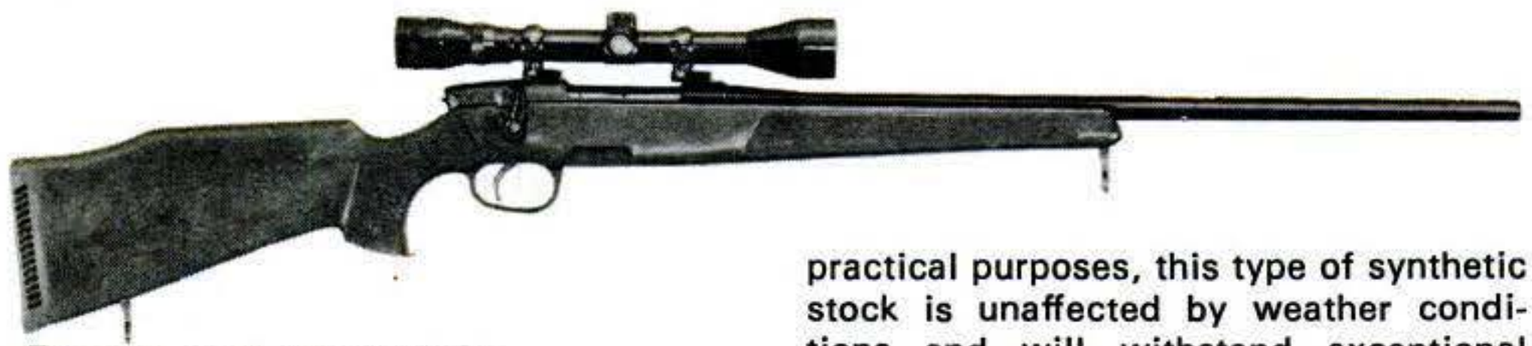
This latest Browning is the only pump shotgun with a magazine cutoff. This allows you to switch the round in the chamber without changing the shells in the magazine. And you can unload the magazine simply by depressing the cartridge stop, instead of cycling all of the shells through the chamber and out the ejection port.

I especially like the slide safety conveniently located on the top rear of the receiver. This makes the BPS doubly attractive to southpaws. Bottom ejection, of course, also is a boon, since the hulls are ejected downward, not in front of the left-hander's face as with side-ported guns. The slide release is big and has deep serrations, so you can operate it easily, even while wearing heavy gloves. Most shooters will like its position at the rear of the trigger guard.

A three-inch chamber adapts the BPS to three-inch magnum as well as to all 12-gauge 2¾-inch shells. You can even mix them in the magazine. There's a choice of 26-, 28-, or 30-inch barrels in improved cylinder, modified or full choke. My sample gun with a 30-inch tube is a longish 50¾ inches overall and weighs just under 7½ pounds. For faster handling, I'd prefer the 26-inch barrel. Longer barrels don't shoot farther or hit harder.

The BPS handles and shoots very well, I found. The pump action, with its double bars, is smooth and fast. The high ventilated rib suits me just fine. Not only good-looking, the checkered walnut stock and slide handle are comfortable, too. And there's a recoil pad to ease the kick of heavy loads.

Like most of the current crop of Brownings, the BPS is made in Japan by Miroku Firearms Mfg. Co. The quality is very good. Suggested retail price of the BPS is $209.95. Supply this fall will be limited. From Browning, Rte. #1, Morgan, Utah 84050.



Rough-and-ready rifle

Some sporters with their fancy walnut stocks are just too pretty and vulnerable to take afield in really rugged country. Also, wood is an unstable material susceptible to changes that adversely affect accuracy [On Target, May]. To professional hunters and others who put reliability before looks, the Austrian firm of Steyr-Daimler-Puch AG now offers a virtually indestructible version of its popular Mannlicher Model M sporter called the Professional.

This rifle has a rust-resistant Parkerized finish and its stock is Cycolac ABS, the tough stuff used in football helmets, boat hulls, and recreation-vehicle bodies. Steyr also uses Cycolac for the stock of the similar SSG69 7.62mm sniper rifle it furnishes the Austrian Army. For all practical purposes, this type of synthetic stock is unaffected by weather conditions and will withstand exceptional abuse without chipping or cracking.

Based on the well-proved Steyr Mannlicher bolt action with its handy detachable five-shot rotary magazine, the Model M Professional has a 23½-inch barrel and weighs about 7½ pounds. It is chambered for calibers 6.5x55 Swedish, 6.5x57 Mauser, 270 Winchester, 7x57 (7mm Mauser), 7x64 Brenneke, 7.5x55 Swiss, 30-06, 8x57JS (8mm Mauser), and 9.3x62 Mauser. All the cartridges except 6.5x57 are available in the U.S.

Price, without sights, is $399.95. The same rifle with blued finish and walnut stock costs $100 more.

Mannlicher rifles are distributed in the U.S. by Steyr-Daimler-Puch of America Corp., Arms Division, 3560-64 Roger E. Chaffee Blvd., Grand Rapids, Mich. 49508.

Scoping the "Old 94"

Millions of hunters own Winchester Model 94's and a lot of them want it equipped with a scope sight. To avoid interference with this rifle's top ejection, the scope must be mounted in an offset position on the left side instead of the usual low-over-the-receiver installation. This has meant drilling and tapping the receiver (a job for a gunsmith) to attach the required side mount base.

Now it's a simple do-it-yourself operation. W. R. Weaver Co. (El Paso, Tex. 79915) just introduced a new side mount base, No. 3B, that uses existing holes in the Model 94 receiver. This base, priced at $2.50, is used with the $13.95 Weaver one-inch detachable long side mount. My choice of a scope for this Winchester is Weaver's long-popular 2½-power K2.5 model, which sells for $57.50. It's perfect for fast shooting in woody or brushy country with either the Dual X or the post-and-crosshair reticle.

Compact rifle rest

To minimize the human element when sighting-in or testing rifles and ammunition, I always shoot from a bench rest. But my precisely adjustable tripod and special leather sandbags make a bulky rig, rather expensive and really not practical for the occasional shooter. Now Hoppe's offers the Mini Bench Rest. It costs only $10.50 and I found it ideal for general use.

Sturdily constructed of aluminum alloy, this compact rest measures 3½ by 5½ inches when retracted and weighs just 11 ounces. It has a padded cradle wide enough to accommodate a beavertail forearm, and provides a vertical adjustment of 2½ inches. The base is drilled for attaching to a board or table.

I keep a Mini Bench Rest tucked away in a corner of my shooting kit, handy for those times when a rifle needs support. It's a mighty useful gadget and, in my opinion, no rifleman should be without one.

From Hoppe's, P.O. Box 97, Parkesburg, Pa. 19365. PS

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Zephyr's Wide-Mount Strut Suspension is brand new, especially engineered for this new car design. Coil springs are computer-selected to match the weight of the vehicle. Shock absorbers are vertically mounted to help provide control on rough surfaces.

ENGINEERED FOR TOUGHNESS.

Passes the same durability tests as our big Lincolns and Mercurys. Created with the help of computer stress-analysis, and rugged materials like high-strength steel. Even a new kind of simplified body. A car built tough.

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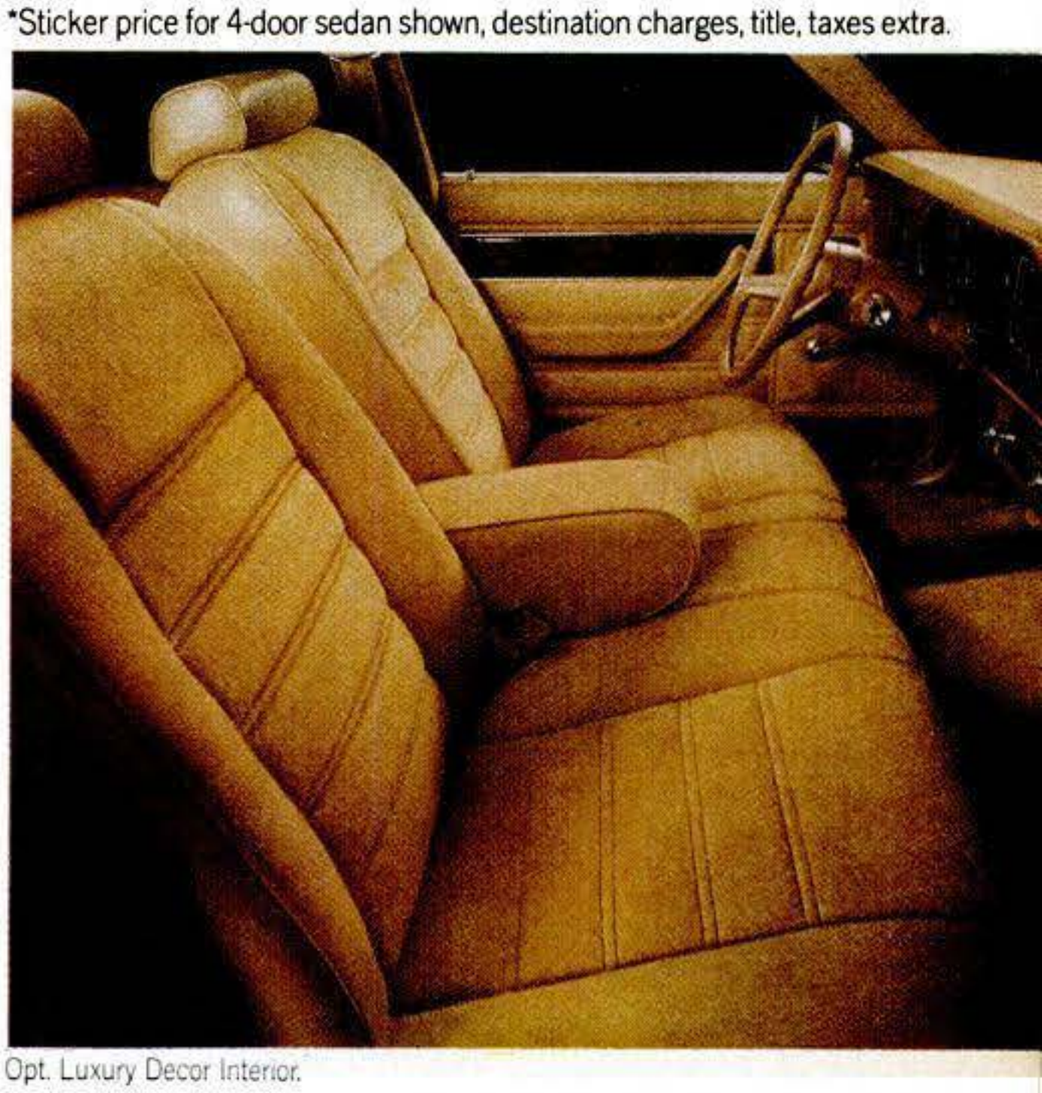
Zephyr has the same type of steering as many high-performance cars: rack-and-pinion steering for precise, responsive control. Also available: variable-ratio rack-and-pinion power steering, for precision *and* ease.



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75TH ANNIVERSARY

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DETROIT REPORT

By JIM DUNNE

Whose Rabbit is prettier?

When VW begins building the Rabbit in Pennsylvania starting next April, it will face the problem of selling a German-built version of the car against the American car in the same showroom. And because the U.S. Rabbit will have a number of styling changes, the customers will readily note the difference. What'll the new car look like? Rectangular headlights are a natural, and a new grille is also planned. But the basic chassis and body will remain much the same. One plan is to sell only a high-priced version of the U.S. Rabbit, while a bargain-basement model is imported from Germany. The problem will resolve itself within a year when the U.S. plant reaches full production and German output is no longer needed here. Body and chassis of the U.S. car will have made-in-America parts, but the engines—both gasoline and diesel—will continue to be made in Europe.

Engines get smaller

Pontiac will double the production of 301-cu.-in. V8 engines to meet the increased demand expected during 1978. Smaller V8's like the 301 are quickly taking the place of the big 400 and 455 V8's of years past, a development that's causing few problems with buyers, but real headaches for the companies. They can't build enough to meet the demand. The 301 with four-bbl.-carburetor engine in this year's Grand Prix outperforms the 400 V8 used in the 1976 GP, according to Pontiac tests, and that's basically why the smaller engines are taking over. With the lighter bodies in the '78 intermediates, the smaller engines do just as good a job, and get better fuel economy to boot. Fuel-economy average for the 301 GP is over 19 mpg (combined city/highway) vs. 17 mpg for last year's 400.

A four or V6 in your future

GM's plans for 1984 cars call for only four-cylinder and V6 engines, and the fours will outnumber the sixes two to one. But the engines of the future will be quite different from present designs, with diesels, turbochargers, and sophisticated vibration dampers becoming as common as automatic transmissions. The move has already started. Diesels will continue to grow in number, and engine-balancing of the type developed in the even-firing Buick V6 and the Dodge Colt Silent Shaft will spread to new power plants. The turbocharger seems assured a big role in performance cars of the future.

Air-bag alternative

Despite the government ruling that calls for passive restraints in the 1984 cars, the air bag is not expected to be installed in every automobile. Passive restraints also include automatic seat belts of the type developed for the VW Rabbit. They require no buckling up, and satisfy the protection requirements of the Department of Transportation. A recent study by VW shows that there have been no reports of "fatalities [or] life-threatening injuries" involving passengers in automatic-belt-equipped Rabbits. More than 65,000 Rabbits with the passive belt system are now on U.S. roads. VW reports that more than 93 percent of Rabbit drivers involved in accidents surveyed were wearing belts—an incredibly high proportion, as current safety-belt usage for all cars is 20 percent or below.

Seville gets fourth computer

When you order the Tripmaster option on a 1978 Seville, you get an on-board computer that reports information such as instantaneous fuel economy, estimated time of arrival, total gallons of fuel remaining, and miles to destination. In addition, it will flash information about the electrical-system voltage, engine rpm, and engine temperature. Tripmaster has a calculator-like keyboard on which the driver punches his questions. Answers are displayed on the digital clock screen. Seville's other three computers control fuel injection, spark advance, and body level. Cadillac thinks that a single computer will be designed soon to do all the automatic jobs and serve as an information center.

No tears for Vega

Chevrolet is saying little about the passing of the Vega aluminum engine, but officials admit that "it had some problems" that led to its premature demise at the end of the 1977 model year. "We were quick to step up to those problems," counters Chevy general manager Bob Lund. In the end, ironically, the engine was one of the most durable built at GM and the only one to carry a 60,000-mile warranty. The technology developed in the revolutionary aluminum block, however, has not been wasted. Aluminum heads will show up soon on other Chevy engines, and one of the newest engines on the market—Porsche's 928 V8—uses the same materials technology developed for the Vega.

Increasing big-car mpg

It's no coincidence that the 350 Olds engine was the first to be converted to diesel fuel. GM wants its biggest, most inefficient engine/model combinations to get the diesel first, since that's where fuel-economy gains will be felt quickest. Later, smaller engines will be converted to diesel operation too. Among the last on the schedule is Chevy's new V6, one of the corporation's most efficient designs, developed specifically for small-car use. But don't get the idea that GM plans to convert completely to diesel power. By 1985, according to present estimates, the corporation might be up to 25-percent diesel.

Super spare

The new small spare tire now offered in midsize GM models may look spindly, but there is nothing odd about its performance. In most normal handling situations, the spare reacts about the same as a standard tire, despite its different dimensions and much higher (60 psi) inflation pressure. The spare uses a 15-by-4-inch wheel, compared with the 14-by-6-inch dimensions of the other four wheels. GM puts a 2000-mile limit on the spare, a figure thought highly conservative but in keeping with GM's belief that the tire should only be used in emergencies, not for everyday driving. The tread pattern of the spare is intentionally noisy to remind the driver to change back to the conventional tire and wheel as soon as the emergency is over. The small spare saves weight and adds about one cubic foot of luggage space to the trunks of the midsize cars.

Neat notchbacks

The consensus of observers at the preview of the 1978 intermediate cars is that the notchback styling of the Chevy and Pontiac is more appealing than the fastback profile of the Buick and Olds. The styling differences were planned to add more contrast among the divisions' cars, but it looks as though Chevy and Pontiac got the best of the deal. Sales of the sedans will be watched closely in coming months.

Turbo Riviera

Buick plans to offer a turbocharged engine in the 1979 Riviera. The car will be completely changed from its present design. The new Riviera will be smaller, will be built on a 114-inch wheelbase, and will have front-wheel drive for the first time. Biggest engine in the line will be the 350-cu.-in. V8, but Buick will feature a turbocharged 231 V6 like the one in the 1978 Regal. Styling of the sporty Riv coupe will be conventional. It will look a little bigger than the Regal, but share many of its exterior lines. Independent suspension will be featured in place of a solid rear axle, another first for a Buick model. PS

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People write to PENNZOIL

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Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

Multi-Purpose Grease. Is there any one grease I can use for the general lubrication of my car? I am confused by all the greases I see on the market including wheel bearing grease, white grease, moly grease, etc.

J. H., Bellevue, Washington

There are many different soap base greases on the market and many of them have special applications. However, for general chassis and wheel bearing lubrication, you can use Pennzoil Multi-Purpose Lubricant #705. If your car is equipped with disc brakes, a special lubricant, Pennzoil Hi-Temp Lubricant WBL 909, should be used in the wheel bearings due to the high temperatures.

Oils for Harley. According to the owner's manual for my new Harley Davidson Motorcycle, there are 3 grades of oil I can choose from: 75, 58 and 105. I have had excellent results using Pennzoil in my cars and would like to use it in my motorcycle. Which grades of Pennzoil correspond with these Harley Davidson recommendations?

K. L., Monroe, New York

The Harley Davidson grades referred to are as follows:

58 SAE 30
75 SAE 40
105 SAE 50

Pennzoil Z-7 Motor Oil in these respective grades is entirely satisfactory for use in your motorcycle. If you prefer a multi-vis oil, our 4-Stroke Motorcycle Oil which is 20W-50 would also be satisfactory.

Filter Fit. I have been experiencing difficulty in removing the used oil filter from my automobile. Can you give me any advice on installing an oil filter so it will be easier to remove when it comes time to replace it?

F. N. C., Coeur D'Alene, Idaho

When installing a Pennzoil oil filter, always pre-oil the gasket with engine oil and tighten no more than 3/4 turn after contact with base. Overtightening may deform the gasket and this frequently causes leaks. In addition, when the gasket cures from engine heat, it may actually bond itself to metal, making removal extremely difficult. Follow instructions on the filter label for best results.

Through Thick And Thin. Is it true that multi-viscosity oils will not hold their viscosity under high heat conditions? I am planning to install an oil temperature gauge and was wondering about an oil such as 10W-40.

K.L., FPO San Francisco, CA

A multi-viscosity oil such as SAE 10W-40 has the same flow characteristics as an SAE 40 at such high temperature as 210°F., and it will not break down to any extent in viscosity during a normal interval between oil changes.

Diesel Difference. I own a 1974 Peugeot Diesel automobile, and in the mountains, where I have my summer house, I find it difficult to locate diesel fuel stations. Is there a difference between regular No. 2 home heating fuel and diesel fuel purchased at a service station? I am curious to know if home heating oil can be used in an emergency without harm in my Peugeot.

C.B., Westfield, New Jersey

We would not recommend the use of home heating fuel for a diesel automobile engine. A No. 2 diesel fuel has a maximum ash content and minimum cetane number specification to meet, whereas a No. 2 home heating fuel does not. Specifying a maximum ash content results in a "cleaner" burning fuel. The cetane specification insures a fuel of the proper combustion qualities.

Mixables. I am ready for an oil change, and have a question about the compatibility of your motor oils. Can 4 quarts of Pennzoil SAE 10W-30 be added to an engine which has one quart of SAE 20/20W in the oil filter, without any harmful effects?

W.E.H., Detroit, Michigan

All Pennzoil Motor Oils are completely compatible, so it is safe to mix an SAE 10W-30 oil with the SAE 20/20W already in the filter.

Get in Gear! I drive a 1973 Fiat. For transmission and axle lube, the owner's manual recommends an SAE 90 (not EP) gear oil containing an antiwear additive. For the steering box, an SAE 90 EP oil is recommended. What does the "EP" stand for?

D.F.L., Fort Bragg, N.C.

"EP" stands for extreme pressure. An extreme pressure (EP) lubricant is required for differential gear lubrication, as indicated in your owner's manual.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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ADVENTURES IN ALTERNATE ENERGY

A monthly sampling of projects PS readers have devised to conserve or replace fossil fuels

Clarence Kenney: Wind power for home heating

By E. F. LINDSLEY

RACINE, WIS.

What's the least costly and most effective way to use the wind's erratic power? The direct production of heat by churning confined air, thinks Clarence Kenney, 72-year-old retired turbine engineer, who has spent the past several years developing and testing such a wind-powered heating system for his home.

The idea of getting thermal energy directly from paddle-wheel agitation of air or water is not a new one, but its full potential has apparently never been explored. (Researchers at Cornell University are working on the concept, a report of which will appear in a future issue of PS.) Most windmill projects featured in this series have involved production of electricity for lights or vehicles [Aug. '75; Feb. '76; July '76; Apr. '77]. Even Jack Krueger's windmill-heated North Dakota house [Jan. '76] uses electric-resistance heating.

Kenney takes another tack

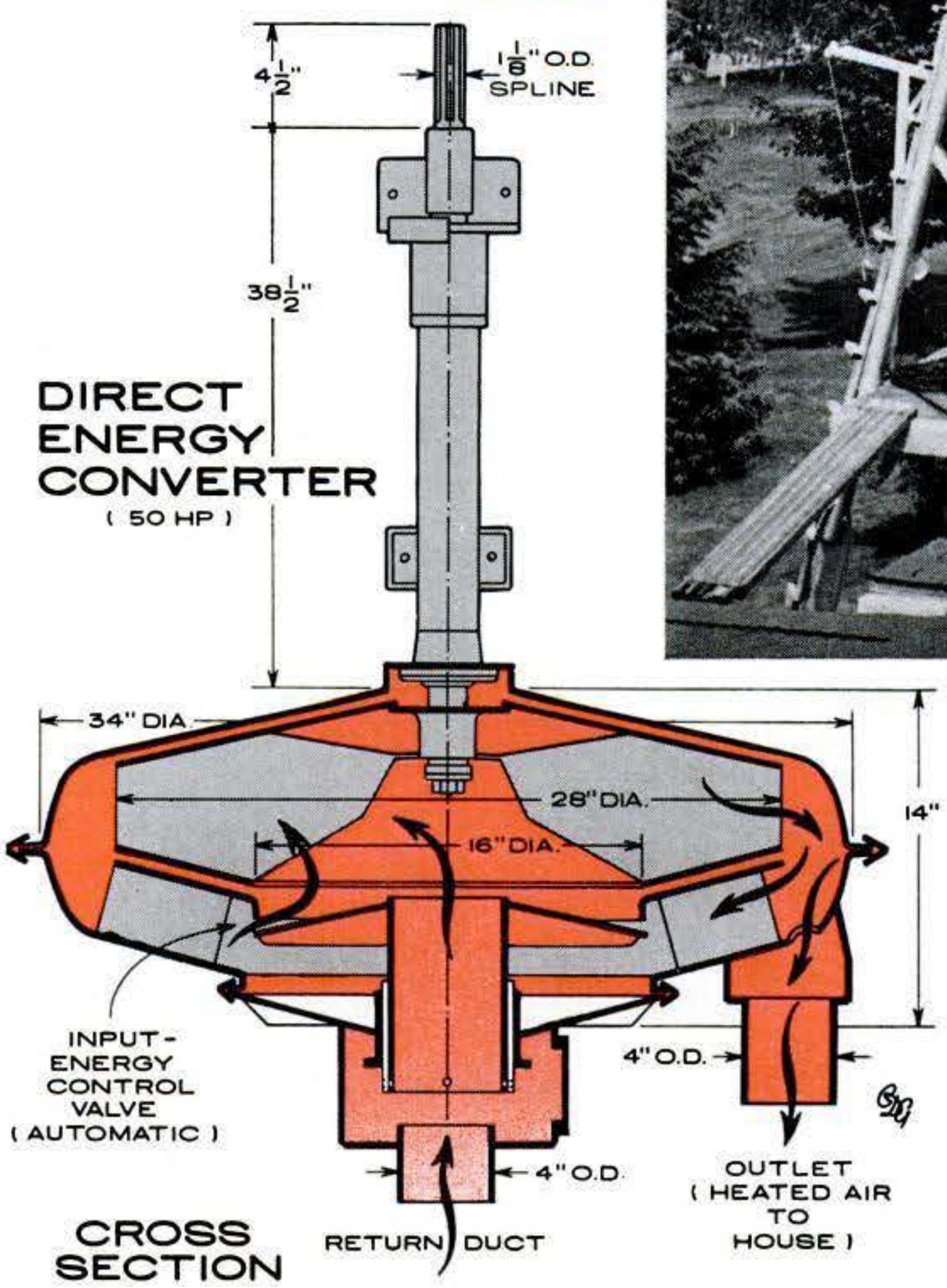
Direct heat from windmills is simplicity itself: Rotate a paddle wheel inside an insulated chamber and the surrounding medium (air or water) gets hot. The mechanical energy from the wind is converted into heat even though the air is not really being compressed. Kenney experimented with water at first, but as soon as it reached the boiling point (100° C), it started to cavitate, producing steam bubbles. That's when Kenney realized he'd have to pressurize the converter to obtain good efficiency. Add to that the problems of leakage and weight, and you see why Kenney decided to forget about water as a medium.

The next step, as with solar, is storage: a rock- or liquid-filled chamber to hold unused heat and provide a backup reservoir when the wind isn't blowing. This is still in the planning stages—Kenney is testing outputs and mechanical structures. Even without storage, he's succeeded in pushing heated air into his house at three to four degrees above room temperature.

At the controls

As might be expected from a man

Continued



Cross section of paddle-wheel heat converter reveals flow of air that's heated by spinning blades. Bowl shapes are of spun steel; bearing assembly is adapted from half an AMC rear-wheel assembly. Automatic temperature-sensitive control opens and closes valves as needed to direct heated air from converter through insulated ducts into house.

Tapered upper tower was rolled from 10-gauge steel. Wedge-shaped framework below turbine is vinyl-covered airfoil to reduce "wind-shadow" effect on blades. Insulation of bowl-shaped heat converter and inlet and outlet pipes was underway when photo was taken.

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Pocket CB

New integrated circuit technology and a major electronic breakthrough brings you the world's smallest citizens band transceiver.

The PocketCom measures approximately ¾" x 1½" x 5½" and easily fits into your shirt pocket. The unit can be used as a personal communications link for business or pleasure.

Scientists have produced a personal communications system so small that it can easily fit in your pocket. It's called the PocketCom and it replaces larger units that cost considerably more.

MANY PERSONAL USES

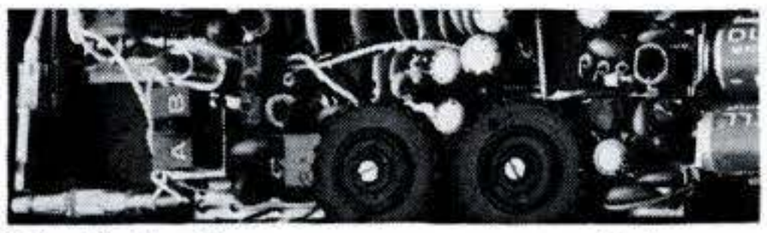
An executive can now talk with anybody in his office, his factory or job site. The housewife can find her children at a busy shopping center. The motorist can signal for help in an emergency. The salesman, the construction foreman, the traveler, the sportsman, the hobbyist—everybody can use the PocketCom.

LONG RANGE COMMUNICATIONS

The PocketCom's range is limited only by its 100 milliwatt power and the number of metal objects between units or from a few blocks in the city to several miles on a lake. Its receiver is so sensitive, that signals several miles away can be picked up from stronger citizens band base or mobile stations.

VERY SIMPLE OPERATION

To use the PocketCom simply turn it on, extend the antenna, press a button to transmit, and release it to listen. And no FCC license is required to operate it. The PocketCom has two Channels—channel 14 and an optional second channel. To use the second channel, plug in one of the 22 other citizens band crystals and slide the channel selector to the second position. Crystals for the second channel cost $7.95 and can only be ordered after receipt of your unit.



The PocketCom components are equivalent to 112 transistors whereas most comparable units contain only twelve.

A MAJOR BREAKTHROUGH

The PocketCom's small size results from a breakthrough in the solid state device that made the pocket calculator a reality. Scientists took 112 transistors, integrated them on a micro silicon wafer and produced the world's first transceiver linear integrated circuit. This major breakthrough not only reduced the size of radio components but improved their dependability and performance.

BEEP-TONE PAGING SYSTEM

You can page another PocketCom user, within close range, by simply pressing the PocketCom's call button which produces a beep tone on the other unit if it has been left in the standby mode. In the standby mode the unit is silent and can be kept on for weeks without draining the batteries.

SUPERIOR FEATURES

Just check the advanced PocketCom features now possible through this new circuit breakthrough: 1) Incoming signals are amplified several million times compared to only 100,000 times on comparable conventional systems. 2) Even with a 60 decibel difference in signal strength, the unit's automatic gain control will bring up each incoming signal to a maximum uniform level. 3) A high squelch sensitivity (0.7 microvolts) permits noiseless operation without squelching weak signals.

EXTRA LONG BATTERY LIFE

The PocketCom has a light-emitting diode low-battery indicator that tells you when your 'N' cell batteries require replacement. The integrated circuit requires such low power that the two batteries, with average use, will last weeks without running down.

The PocketCom can be used as a pager, an intercom, a telephone or even a security device.

MULTIPLEX INTERCOM

Many businesses can use the PocketCom as a multiplex intercom. Each employee carries a unit tuned to a different channel. A citizens band base station with 23 channels is used to page each PocketCom. The results: an inexpensive and flexible multiplex intercom system for large construction sites, factories, offices, or farms.

NATIONAL SERVICE

The PocketCom is manufactured exclusively for JS&A and is the unit currently used on the hit TV show, Charlie's Angels. JS&A is America's largest supplier of space-age products—further assurance that your modest investment is well protected. The PocketCom should give you years of trouble-free service, however, should service ever be required, simply slip your 5 ounce PocketCom into its handy mailer and send it to our prompt national service-by-mail center.

GIVE IT A REAL WORKOUT

Remember the first time you saw a pocket calculator? It probably seemed unbelieveable. The PocketCom may also seem unbelieveable so we give you the opportunity to personally examine one without obligation. Order only two units on a trial basis. Then really test them. Test the range, the sensitivity, the convenience. Test them under your everyday conditions and compare the PocketCom with larger units.

After you are absolutely convinced that the PocketCom is indeed that advanced product breakthrough, order your additional units, crystals or accessories on a priority basis as one of our established customers. If, however, the PocketCom does not suit your particular requirements perfectly, then return your units within ten days after receipt for a prompt and courteous refund. You cannot lose. Here is your opportunity to test an advanced space-age product at absolutely no risk.

A COMPLETE PACKAGE

Each PocketCom comes complete with mercury batteries, high performance Channel 14 crystals for one channel, complete instructions, and a 90 day parts and labor warranty. To order by mail, simply mail your check for $19.95 per unit (or $39.95 for two) plus $2.50 per order for postage, insurance and handling to the address shown below. (Illinois residents add 5% sales tax). But don't delay.

Personal communications is the future of communications. Join the revolution. Order your PocketComs at no obligation today.

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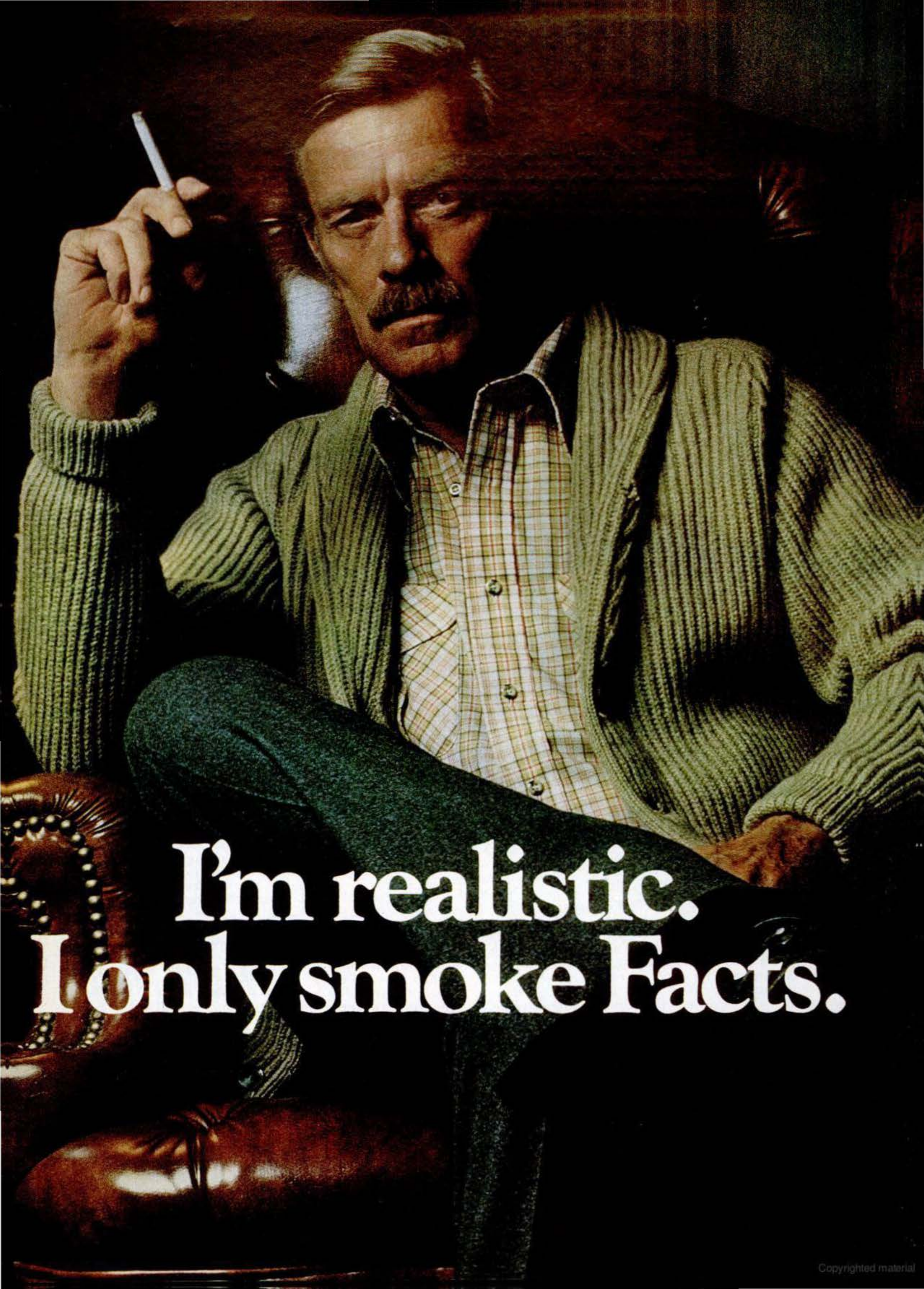

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Wind power for home heating

[Continued]

who's spent his life working with complex power-plant turbine controls (and is still a consulant), Clarence Kenney has concentrated on safety and controls for his windmill project. Novel features of his system include:

- A servomechanism driven by the wind to control direction.
- A patented blade-mount system to take centrifugal load off the bearings, preventing brinelling (impact wear) and eventual blade-lock.
- A signal generator to compare rotor speed and wind velocity in order to match the load to the wind more precisely.

Safety controls

Kenney opted for a two-blade rotor because of its lower cost and its governability. He recognized, however, that destructive gyroscopic forces during sudden shifts in wind direction have been the bane of many two-blade designs. Hence, his servo-driven directional control that moves the turbine slowly and prevents overspinning.

Dimensions of the converter, mounted near the base of the tower, are determined by the size of the AMC rear-wheel assembly. The tapered upper section of the tower (see photo) is rolled from 10-gauge steel; drive shaft and support bearings are located there.

It all sounds complex, but it's done with rugged mechanical parts and no electric power equipment. Kenney claims the heat output ranges between 100° and 550° F (37° and 287° C).

Kenney hopes to find someone to build a pair of aerodynamically and structurally sound blades for a 10-meter-diameter turbine to replace his present 18-foot turbine. So far, he's found no one.

To ask a specific question, send a stamped return envelope to Clarence Kenney, 119 Stuart Road, Racine, Wis. 53406. PS

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To enter, send us black-and-white glossies (one photo should show you demonstrating your device) plus pertinent text and sketches. Write your name, address, and Social Security number on each item. No material can be returned unless you enclose a stamped, self-addressed envelope.

Since space won't permit us to present projects in detail, we'll expect inventors to answer any reasonable query from readers, if it's accompanied by a stamped envelope.

Mail entries to Energy Adventure, Popular Science, 380 Madison Ave., N.Y., N.Y. 10017.

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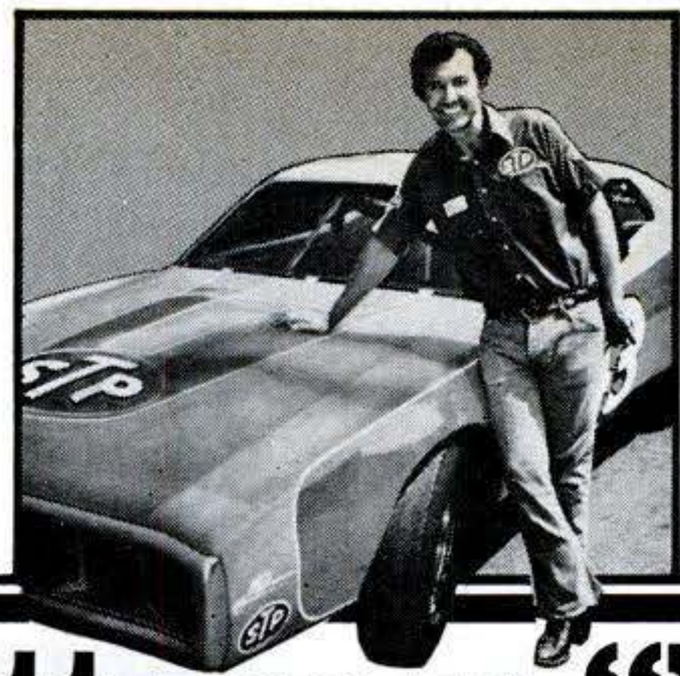

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Thermal-storage furnace

—can it make electric heat practical?

A new way to store energy at night for daytime use can help the utilities—and you—by leveling demand

By EVAN POWELL

Power companies have a problem: They must maintain the equipment and capacity for providing the maximum amount of power needed during periods of peak demand. But when demand is low, the generating and transmitting capacity and equipment, while still available, are largely unused. Result: The utilities charge us a premium.

One way to smooth out the daily high and low peaks of power demand is the two-rate or demand-metering structure ["Demand Metering . . . Can It Slow Your Soaring Power Costs?"—PS, July '75]. But some utilities are finding that this in itself causes only minor changes in daily demand curves.

American Electric Power Systems, parent company of seven interconnected utilities ranging from Michigan through the Ohio Valley into West Virginia, has begun to look at another concept, called the residential energy storage program. Its goal is to develop a system that stores enough heat in an eight-hour period to provide home space conditioning and hot water for 16 hours.

It's an all-inclusive effort: work with manufacturers to develop electric thermal storage equipment; monitor operation and performance of such systems; test the customer's reaction to them; and determine payback costs.

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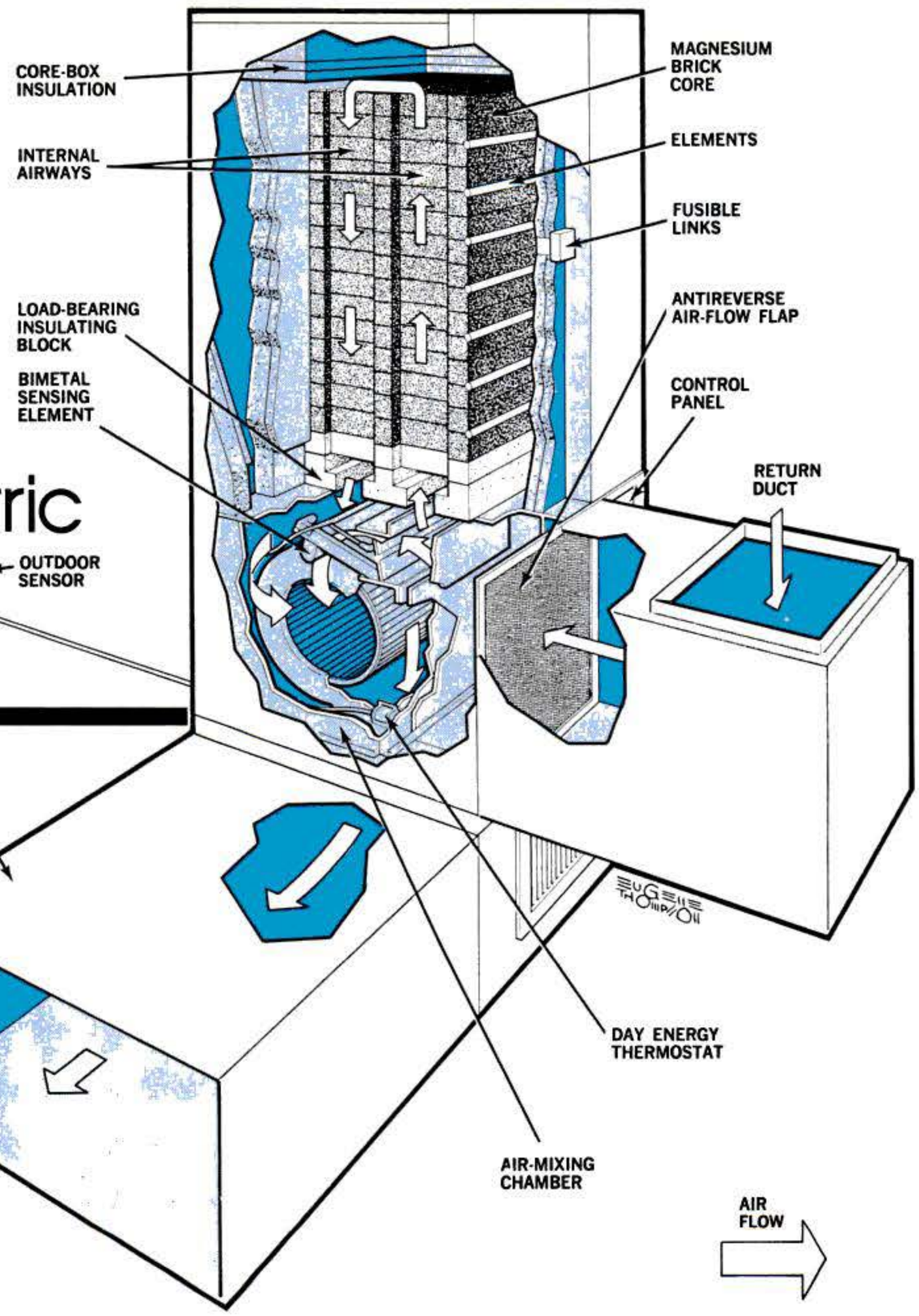

How thermal storage works

The heart of the heat-storage furnace is a core formed of a stack of high-magnesium-content brick (see cutaway in drawing above). During periods of charging, the ceramic material is heated by ceramic-sheathed open-coil nichrome low-watt-density elements, which slip into recesses molded into the bricks. Overnight charge of the model shown is equivalent to 106 kwh of electricity. There are nine 1600-watt elements and 112 bricks in the core. (U.S. versions will have about twice this capacity.) Sides of the cabinet are insulated with Microtherm, a highly efficient (and expensive) insulation, and the core temperature approaches 1400° to 1500° F at full charge. Case emission of the Creda unit over a 24-hour period is estimated at 0.86 kwh. Exterior temperature of the case averages around 140° F.

The hot-water component of the heat-storage system is the A. O. Smith double-insulated 120-gallon Conservationist (not shown). It's fitted with a specially designed sealed-end dip tube to encourage stratification and eliminate turbulence at the bottom of the tank when cold water flows in. Elements are energized in 1000-, 2000-, 3000-, and 4000-watt stages. The system is programmed to sense water-tank temperature when the signal (time clock, ripple current, or radio control) to enter the off-peak period is received. Depending on the charge needed, the control selects the proportion of the heating element's total wattage to be energized for the eight-hour charge.

The controls in the heat-storage furnace (from TPI Corp.) are even more elaborate: When the off-peak signal is received, a thermocouple inside the furnace determines the remaining core charge of heat. At the same time, an outside thermistor determines outdoor temperature. These two values are integrated so the load-leveling control will cycle the furnace to spread the required charge over a full eight-hour off-peak period. The maximum level of charge in the core can be varied from half charge at 60° F outside temperature to full charge at 32° F outside temperature. This keeps heat loss through the cabinet to a minimum.

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Studies indicate that 60 to 70 percent of an all-electric home's energy use is for space conditioning and water heating, loads that lend themselves well to electric thermal storage.

A refractory option

In this country the search for existing equipment that could be adapted to these purposes led to studies of water-storage systems, latent-heat phase-change systems, and refractory systems (using high-heat-capacity materials). Only the third system was felt to show the potential for troublefree performance and workable size. This type of system has been in use in Europe for some time, but the systems used there wouldn't meet sizing or performance standards or the code requirements necessary for the American market.

American Electric Power Systems decided to work with an experienced European manufacturer, Creda Electric Ltd. TPI Corp., an American manufacturer of heating equipment, is cooperating in developing a U.S. version. To round out the package, AEP sought out the services of A.O. Smith Company to develop a load-leveling storage-type water heater.

When I met with engineers from AEP, TPI, and Creda at the TPI test facility recently, I was impressed with the neatness of the storage-system installation. It looks much like two ordinary electric furnaces standing side by side. Actually, this version is a modified Creda unit. Still in the design stages, the U.S. version will have almost twice the capacity of these test units. In addition, both storage and resistance heating for off-peak periods will be housed in the same cabinet, one that will take up little more space than an ordinary furnace but will be quite heavy, possibly weighing as much as a ton. (The 100-kw test unit weighs 1380 pounds.)

The magnesium-based bricks used are deceptive. I was handed one only slightly larger than an ordinary brick, yet it must have weighed four times as much.

What you can expect

If the results of this first winter's testing are a good indication, the only difference you are likely to notice with an electric thermal-storage system installed in your home is a substantial reduction in your power bill. The automatic controls on the units obviate any action on your part unless you want to override them manually during particularly cold weather. The water heater, for instance, has a "guest-cycle" switch. If you use its 120-gallon capacity during peak time, depressing the button will give you 30 gallons additional water. But pushing the button also signals that you are paying a premium price for heating that hot water.

Since the modified Creda storage units don't have the capacity that their U.S. counterparts will have, engineers were reluctant to install the test units in some of the colder areas served by AEP. Even so, I was told of one homeowner whose test installation was checked by a technician the morning after a 25-below-zero night. When the homeowner was asked at what time he initiated the manual override switch to turn on the electric furnace, he replied that he never touched the switch!

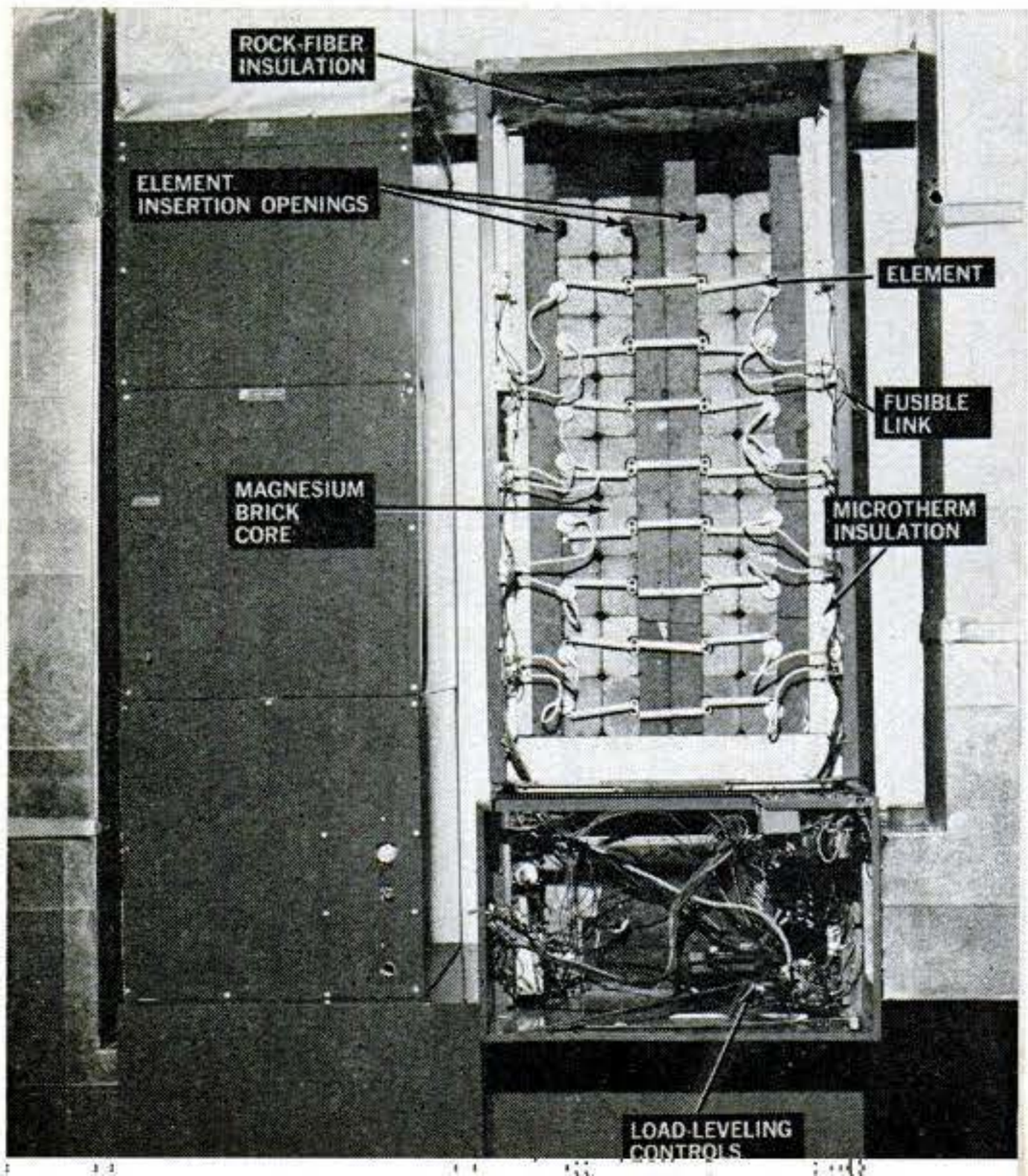
Each test installation was connected to a special two-rate meter to monitor the amount of power used both at peak and off-peak periods. Several of the homes were heated all season with *zero* use of the furnaces at peak periods.

Load-leveling design

The prototype control systems of both furnace and water heater are designed to "stagger" the "on" load, to prevent a sudden, huge demand on the power company's facilities should, in future use, thousands of units come on-line at the same time. The power input is "stepped" in various wattage increments.

Without this load-leveling, the utility would achieve only a few hours of extension of on-peak loads instead of a full eight-hour off-peak spread. It's not necessarily the magnitude of the peak; it's the smoothing of the daily load curve that assures a utility's operating efficiency. The control packages can be adapted to the type of initiation for any two-rate system, including ripple current, radio control, or time-of-day meter.

Whether you'll eventually have such a system in your home could well be determined by the final results of the extensive testing being conducted this season, when more test homes in the AEP system will be added. Cost factors look favorable: The projected cost of a complete electric thermal-storage system could run $600 to $700 above that for normal equipment, but could result in savings of $130 to $200 a year—a 3¼- to five-year payback. PS



Heat-storage furnace installation looks like dual-furnace setup (left). U.S. version will be larger, but will combine functions of both units seen here on Virginia test installation. Elements are low-watt-density type for long life; those in prototype unit were easily replaceable by unclipping leads and pulling straight out of brick (right). Air passages and openings for inserting elements are cast into brick. Elements and brick will be shipped separately and placed in cabinet by installer.

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Popular Science

PS | What's News

The government has been putting pressure on Detroit to deliver cars that give better gas mileage, and Detroit has been putting pressure on its suppliers to redesign their products to help achieve this goal. And nobody, perhaps, has been getting as much pressure from the car makers as the tire people in Akron. Radials gave about five percent better gas mileage when they were introduced a few years ago. Now Detroit has directed the tire companies to do something else to produce yet better mileage. The basic solution the companies are choosing is straightforward enough; they're boosting air pressure. It works, but ride suffers, so some new engineering has to be done to compensate.

All companies have been working on this problem, but Goodyear is apparently the first to come out with an entirely new product, designed primarily with gas saving in mind. When we heard about the new elliptic tire and the claims made for it, we dispatched Group Editor Herb Shuldiner, who has written about tires many times before, to Akron to find out about the new design. And we asked him to arrange to have a cover shot while he was there.

You may not have given it much thought, but shooting an interesting picture of a tire is a tough job. To begin with, it's black. And second, the new tire, while it contains significant engineering innovations, still looks pretty much like any old tire.

First thing Herb had to find was a location. A brick street would be perfect, he thought. And since nearby Canton was once a center of the brick-manufacturing industry, many of Akron's streets used to be paved with brick. Alas, no more. But Herb located Uhler Avenue, one of the few remaining brick streets in Akron, and selected a site on that thoroughfare for the picture.

Then it became photographer Ron Stockwell's problem. And there was a problem. The low perspective distorted the pile of tires at the left. So Stockwell had to prop up the tires at an angle to make them look straight—he actually jacked them up on one side until they appeared level to the Bronica camera's 50mm wide-angle lens. Then Stockwell shot 96 variations of the picture you see so that we'd have plenty of choices for the final selection.

To find out what the new tires can do and how they do it, read Herb's story starting on page 102.

The shuttle

After all we've written about it over the last several years [major features in Nov. '74, June '75, Aug. '75, and Jan. '77], I couldn't resist going to Edwards Air Force Base in California to see the first free-flight glide tests of the space shuttle. It was worth the trip. I was 500 feet from the runway directly opposite liftoff point when the coupled giants—you really can't believe how big they are until you see them close up—took off as scheduled at eight o'clock in the morning.

As you know, everything went smoothly; the only thing even marginally out of the ordinary was that the shuttle turned out to be a little better airplane than predicted. Pilot Fred Haise said later that it handled more like a fighter than an airliner, and it didn't seem to want to land. I had picked a place along the landing area near the projected touchdown spot. Actually, the big bird first touched its home planet between one and two miles downrange, since it turned out to have somewhat more lift than expected. That caused no problem, of course. In fact, it's to take care of just such unexpected occurrences that such test flights are held at Edwards on a 15-mile-long dry lakebed, where there's plenty of room for error.

I've seen a lot of launches since the beginning of the space age, launches of everything from relatively small rockets bearing satellites to the mighty Saturn V that took men to the moon. But I've never been more impressed than I was at this first shuttle test flight. Yet this wasn't really a launch at all; it was simply a drop test with the shuttle totally unpowered, a simple experiment to confirm its gliding characteristics and see if it could land as predicted. I guess what made it exciting was the knowledge that this is the earth's first genuine spaceship. One-shot rockets like the Saturn V are incredible technical accomplishments, of course, but they are clearly nothing more than the very early stages of space technology. Before spaceflight can become as routine as air travel, we've got to have reusable craft that can fly into space, then fly back and land to be used again. And that's what the space shuttle is.

I guess the other thing that impressed me was the incredible competence and confidence of the NASA people. When they got the job of sending men to the moon, a lot of the technology didn't exist, so they invented it, built the craft, sent the pilots off to explore the moon, and brought them back. Then they got the assignment of building the first reusable spaceship. So they set to work and did it. They perform each step as calmly and competently as though it were a daily routine—instead of a history-making feat. Watching them work, I get the impression they could make a brick fly if they got the assignment to do it.

First solar power plant

With the first successful tests of the solar power tower completed [Oct. '75; WN, Nov. '75, Aug. '76, Dec. '76], ERDA has now gone on to begin design work on the first commercial plant that will use the sun's energy to generate electrical power.

The station will be near Barstow, California, and will be operated by Southern California Edison. Contracts for actual fabrication of the plant will be issued within the next six months, and the plant should go into operation in late 1980 or early 1981.

In the design chosen, a cylindrical receiver—the boiler—will sit on top of an 86-meter (283 foot) tower. A field of 1500 mirrors, each with a surface area of 40 square meters, will be computer-controlled to follow the sun and focus its rays on the receiver, where water will be turned into steam, and then used to drive a conventional turbine on the ground to generate electricity. The 10,000-kilowatt plant will cost about $100 million.

Executive Editor

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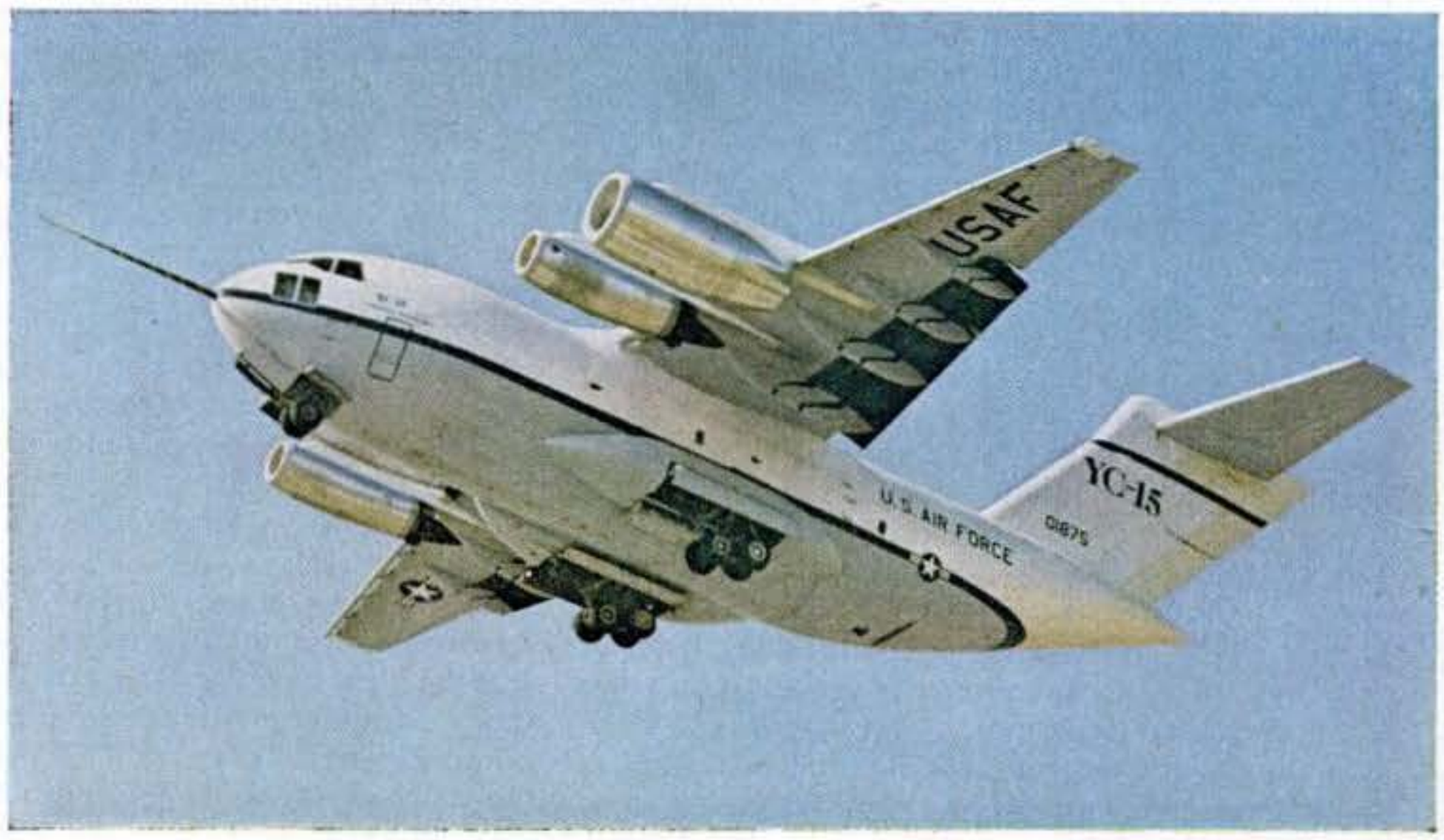
PS editor flies the **new STOL's**

Bulky-bodied YC-14 from Boeing (above) has only two engines, set high and forward. Both YC-14 and McDonnell Douglas YC-15 (right) use powered lift to allow quick takeoff and landing, carrying heavy loads, from short runways. The new STOL's need only 2000-foot runways; the Hercules C-130 they'll replace needs 3500 feet. Thus STOL's can be used at 2½ times as many airfields. In military situations, STOL capability will make it more difficult for enemy gunners or fighters to predict where a supply plane will land, increasing chances of survival in tough combat conditions. One large engine (on the right) makes this YC-15 look unbalanced. It's a 22,000-lb.-thrust General Electric/Snecma of France CFM-56, undergoing tests. Other three are 16,000-lb.-thrust Pratt & Whitney engines, currently standard.



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High-capacity aircraft with near-acrobatic performance, the YC-14 and YC-15 herald drastic changes in airliners

By BEN KOCIVAR

LE BOURGET AIRPORT, PARIS

They are truely ugly-duckling airplanes. Squat, fat, with gigantic tails, they could be chunky-bodied twins except for their engines: One has four jet engines slung under its high wing; the other has only two, mounted strangely high and forward like oversize sunglasses.

But what these two planes lack in sleek lines they more than make up for in startling performance, cavernous interior space, hefty weight carrying, and acrobatic maneuverability. In February, 1976, the POPULAR SCIENCE cover story was my report on the McDonnell Douglas YC-15 after I saw it in test flights at Yuma, Ariz. I also examined the design concept of the Boeing YC-14. At that time it was not yet flying. Now I have flown in both prototypes, in France. As far as we know, POPULAR SCIENCE was the first publication to get the chance.

The two designs are in competition under an Air Force program to develop a modern STOL (short take-off and landing) replacement for the veteran Lockheed Hercules C-130, a four-engine turboprop that has been in production since 1954. The basic goal of the new AMST (advanced medium STOL transport) designs is to carry bigger, heavier loads faster, in and out of smaller airfields, closer to front combat zones. I can see new civilian STOL airliners as spinoffs, useful for both freight and passengers. Such planes could serve many small communities that have no major airports nearby and greatly aid the development of remote regions. The Air Force expects to choose between the Boeing and the McDonnell Douglas designs by year's end.

The two companies have each built two planes. They differ primarily in the way they develop powered lift. The McDonnell Douglas YC-15, being developed in an $89.9-million contract, gets lift for its STOL performance from engine exhaust *under* the wing, directed toward its giant flaps at the trailing edge.

The Boeing YC-14, designed under a $105.9-million contract, develops a lot more lift. Two big 51,000-pound-thrust engines blow exhaust *over* the top of the wing. This upper-surface blowing (USB) is based on a phenomenon known as the Coanda effect. In the 1930's, Belgian physicist Henri Coanda discovered that a fast-moving fluid flowing over a curved surface tends to adhere to that surface. On the YC-14 the engine exhaust is the fluid, and the wing and flap assembly form the curved surface. The flaps directly behind the engine are lowered to almost 90 degrees vertical; the engine exhaust, thus redirected downward, creates powered lift.

So much for the theory. What are they like to fly?

The YC-14

I first flew in the Boeing ship, which had 18 seats on pallets facing a closed-circuit 21-inch TV screen high above. The TV image came from a camera mounted on top of the fuselage near the tail and looking forward over the two engines. What I saw during flight was pretty thrilling, even on a TV screen.

After takeoff clearance the two YC-14 pilots held the brakes while running the engines up to full power. Then, as the brakes were popped, the plane accelerated, and I was rammed back into my seat.

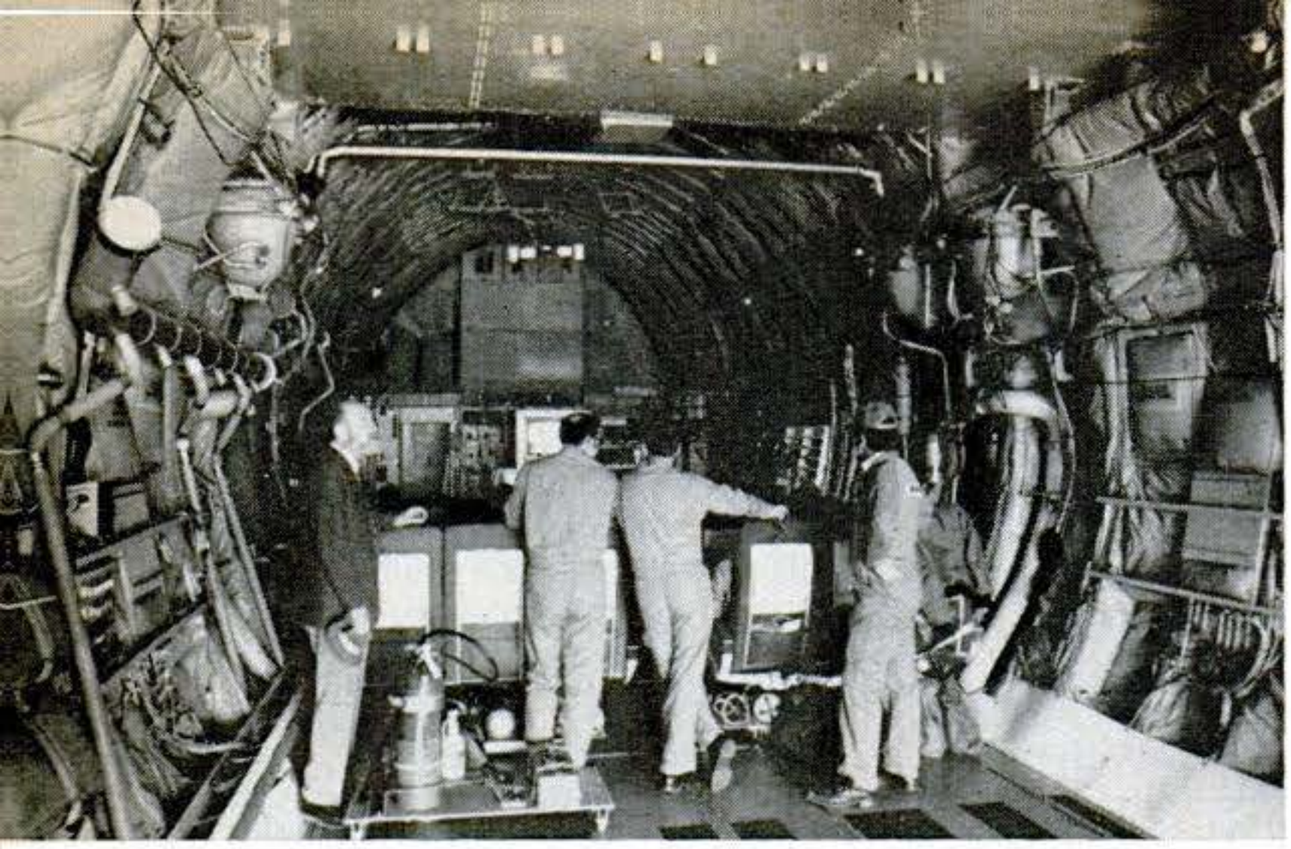
We rolled about seven or eight seconds, and abruptly the nose pitched up. We were in a steep climb that I later learned was about 35 degrees. All I could see on the TV screen was sky. Looking through the tiny porthole windows I could see the green fields around Le Bourget Airport falling away as though we were climbing out in some kind of lethargic rocket ship. We continued in a steep climbing turn and I recalled watching the ship in previous flights go through a complete 360-degree circle within the confines of the airfield and in less than 1000 feet altitude. Tight and tidy.

The test pilots demonstrated several STOL landings, approaching at rather steep six-degree angles instead of the three degrees routinely used by airliners. There was a slight sinking feeling in my stomach as the plane seemed to be settling in fast at a high angle of attack. All the while I could hear the throttle settings and flight controls making slight changes, commanded by a unique triple-redundancy electronic flight-control system made by Marconi-Elliott Avionic Systems Ltd., an English firm.

Touchdowns are firm and much more abrupt than in conventional planes—really power-flying right to the ground. The roll also is unusual. Powerful engine reversers and hard stomping on the brakes bring the transport to an abrupt belt-pushing stop. It's a little hairy even

Continued

Air Force version of YC-14 is shown flying low over Seattle. New STOL's could provide air service to communities that have only private airstrips—or highways—for takeoff and landing. Passenger version would carry about 150.



YC-14 interior shows bare metal, control lines—no insulation. YC-15 is similarly spartan. Author reports both were so noisy he had to wear earmuffs. Interior size is similar, too: about 12 feet wide and high, 45 feet long.

Cockpit of YC-15 was photographed by Kocivar during demonstration flight. He sat behind McDonnell Douglas test pilot who talked two French Air Force officers through their first check flight. Added fillip: a hairy instrument approach.

when you're warned about it beforehand.

YC-15

My flight in the McDonnell Douglas YC-15 was a bit different. The palletized passenger seats faced backward. I tried one takeoff sitting in the cargo section and then was invited to the cockpit to watch a French Air Force general and a colonel get check flights. Both men are fighter pilots with no heavy-transport experience. It added to the thrill.

The YC-15 has four jet engines. In this particular ship three are Pratt & Whitney 16,000-pound-thrust JT8D-17 turbofans, like those used on the DC-9 transport. But the number-one engine on the left is a high-bypass-ratio 22,000-pound-thrust General Electric/Snecma of France CFM-56 for testing. The four engines put out less total thrust than the two big GE CF6-50's on the Boeing ship. As a result, the YC-15 could not perform such steep pullups and extremely short takeoff runs.

Test pilot George Jansen told me, "If we had four of those big engines on this baby, you'd really see something."

Meanwhile, the YC-15 is hardly a slouch. Its powered lift lets it take off at an amazingly low speed. At about 80 knots, substantially less than a similar-size airliner requires, Jansen told the general to pull the stick back and rotate the nose upward to 15-degrees pitch attitude. Up we went—and promptly. Once up to altitude and cruise speed of about 350 knots, we went through a practice approach at 15,000 feet, slowing down to under 200 knots.

To kill forward speed quickly, the YC-15 can use its engine thrust reversers in pairs or on all four engines at once, and can slow down to under 200 knots in less than half the time it takes typical jet transports. It can also lose altitude fast without building up excessive speed. With all four engines reversed it can come down at more than 15,000 feet a minute—quite an elevator ride. This would help the ship evade ground fire in combat areas.

On an approach, as engine power is increased, both lift and induced drag are increased. As a result there is only a slight variation in speed, but the flight path is raised. As power is reduced the flight path is lowered. This ability is used to put the plane on the ground at exactly the spot desired. I wish it were available on private planes. I looked over the pilot's shoulder at the heads-up display known as the VAM (visual approach monitor). It looks like a small pop-up sheet of glass with an aim bar set at the desired approach angle. This makes for a kind of gunsight to be aimed at the desired touchdown point. If the bar is below the point, the pilot advances the throttle to get more lift and raise the flight path. If the aim bar is above the desired spot, he reduces power to lose altitude.

Like the YC-14, the YC-15 is brought in at a six-degree approach angle. And the plane's nose attitude is actually pointed two degrees up. This means the wing is flying at an eight-degree angle of attack. Flying this way right down to the ground without flaring takes some self-control. Test pilot Jansen kept repeating to the colonel now on the stick, "Just hold it there, don't flare, just keep flying it down." He would have had to be firmer with me.

When the wheels touched it was with a solid feel, but not the controlled-crash sensation I had anticipated. Part of the reason for this is the unusually long extension on the landing gear, which takes up much of the shock before the full weight of the plane hits.

Jansen had earlier told the colonel to "hit the brakes hard as soon as we touch." If you do this with an ordinary plane, the tires may blow out. But with the powerful non-skid brakes and the thrust reversers on this big STOL, we just got pushed forward hard against our seat harnesses.

A couple of items are worthy of special note:

- Thrust reversers are used not only for braking but also for backing the planes. The problem in normal installations is that they kick up dirt and debris, which get ingested in the engines. On these STOL prototypes, however, the reversers direct the jet blast upward only. There's no dirt ingestion, and ground personnel can work safely near the plane.
- Both planes have cockpit windows below seat level, so that the pilots can look down as they make their steep approaches.

Future concepts of these big STOL's seem limited only by imagination. They could contribute significantly to the social and economic growth of developing countries by transporting farm and construction equipment into otherwise inaccessible areas. And the big planes could be used for mining and energy exploration.

There are also plans for flying-hospital versions that could go to major disaster areas with medical staff and surgical facilities.

Will the Air Force choose the YC-14 or the YC-15 for development and production? One of these new-technology craft will probably be responsible for the biggest change in airline-type aircraft since the jet engine came into common use 20 years ago. PS

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How good are they? New long-play video-cassette recorders

Slip in the tape, set a timer, and record up to four hours while you're out

By JOHN FREE

Color test patterns, soap operas, and a quiz show flashed onto a TV screen in an engineering lab at RCA's Consumer Electronics division. The series of pictures, separated by brief lapses in synchronization, were coming from RCA's VBT200 video-cassette deck, a remarkably compact machine that can record up to four hours of TV programs on a tape cassette about the size of a paperback.

Seconds before, I'd watched as the programs were recorded and a switch on the VCR was flicked back and forth between modes labeled SP (standard play) and LP (long play). Now, as the machine played back the recorded programs, it automatically shifted playback speeds between 1.3 ips (SP) and the amazingly slow 0.69 ips (LP). Special electronic circuits in the deck kept the pictures very close in quality to off-the-air images at both playback speeds.

RCA's VBT200 is one of about 16 different models of Japanese-made video decks that have suddenly appeared in stores. Despite different brand names and model numbers, though, the newest VCR's use one of two incompatible tape formats: Beta, or VHS (Video Home System). Both formats rely on high-density recording technology first introduced by Sony two years ago. But to boost recording density on ½-inch-wide tape still

Continued

JVC's HR-3300U Vidstar video-cassette recorder tapes up to two hours of material on a single $19.95 cassette. The $1280 machine operates at one speed (1.31 ips) in the VHS (Video Home System) tape format. The deck is the most compact model available (17⅞ by 5 13/16 by 13 5/16 inches) and weighs only 30 pounds. The built-in timer is a standard feature and operates on 24-hour time (6 p.m. is 1800). The deck has non-RF audio/video in and out jacks, pause and audio-dub keys. A two-tube color camera (one tube in the handle) costs $2150 with an electronic viewfinder and zoom lens (top), $1500 with a fixed 25mm lens and optical viewfinder. The adapter used with the GC-3300U camera (above, right) has automatic and manual color-compensation settings. An under-$100 adapter for the camera transfers slides and movie film onto tape.

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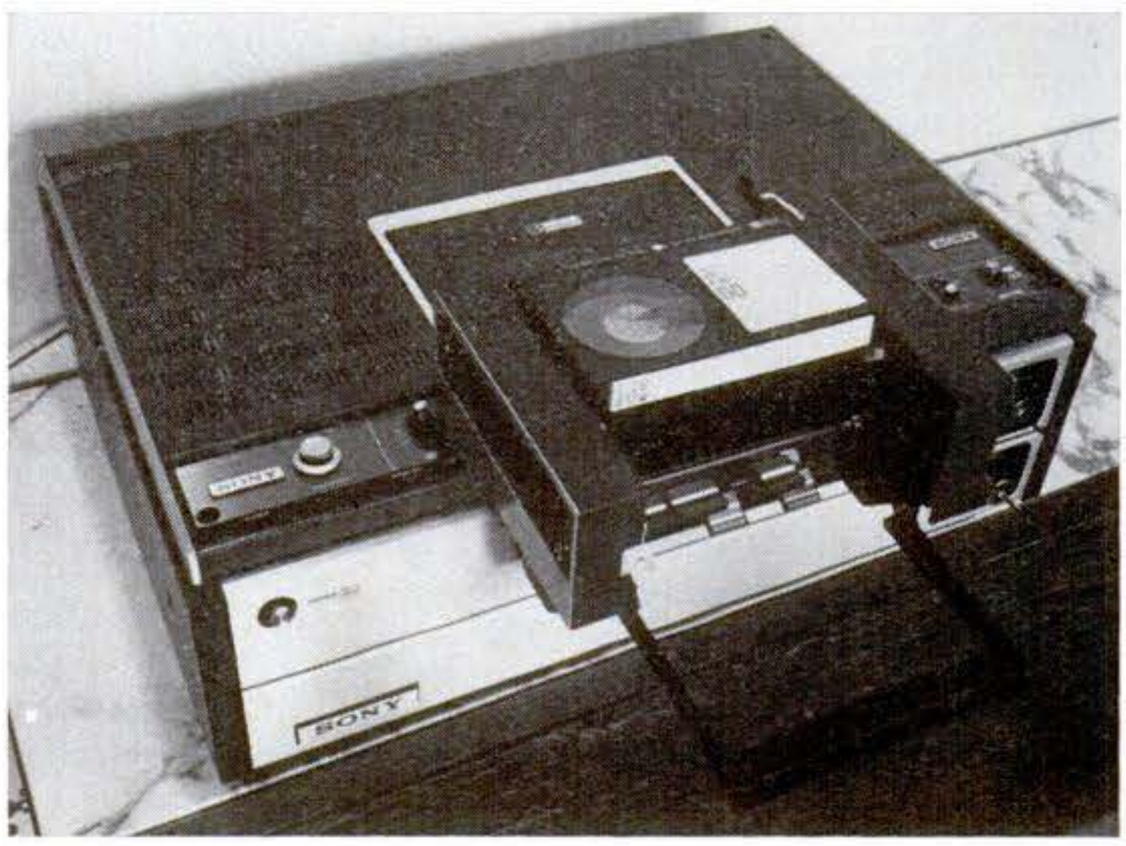
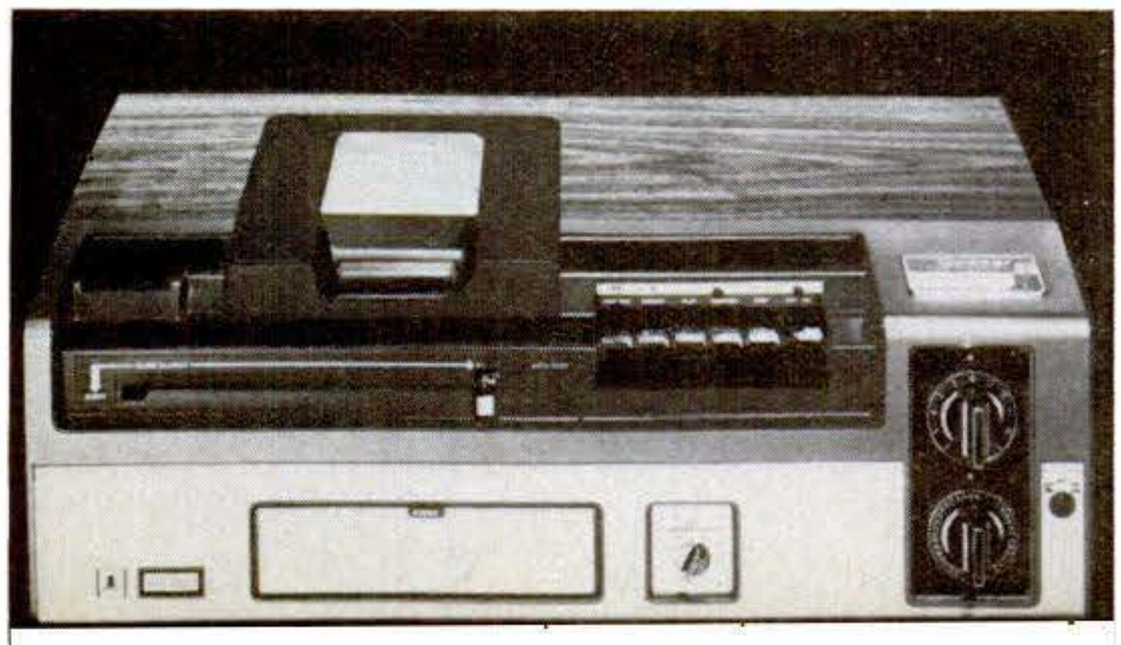
RCA's VBT200 uses the VHS tape format and records two hours on a compact cassette in the SP (1.3 ips) mode, or four hours on the same cassette in the LP (0.69 ips) mode. The $1000 tape recorder has a built-in digital timer for unattended recording, plus keyboard and remote pause controls (10-minute limit). Jacks on the rear panel include audio/video inputs and outputs and the remote pause control. One of two black-and-white cameras available has a zoom lens; switches on both cameras operate the pause function. Four-hour tapes cost $24.95, for the lowest cost/hour among the tape formats.



Zenith's JR900W VCR (left) and Sony's SL-8200 (right) are similar machines with minor differences in external features. Both $1300 decks use Beta-format tape technology and record up to two hours on a $16.95 cassette. Sony markets the under-$100 AG-120 cassette changer, at right, which automatically inserts a second cassette when one runs out; this boosts unattended record/play time to four hours. Zenith says the changer works on its deck, too. The decks have keyboard pause controls (3½-minute limit) and rear-panel jacks for non-RF audio/video inputs and outputs.

Quasar's VR-1000 VCR costs $995 and records two hours on a single $25 cassette. Tape speed is two ips. Dubbed The Great Time Machine, the 1000 has one video head that spins twice as fast (3600 rpm) as the two heads in other decks. An optional timer is $50, and an add-on $10 remote pause switch can be used instead of the keyboard pause function. Unlike other decks, tape remains in the cassette during play and the video-head drum operates inside the cassette. The rear panel has audio/video input and output jacks for camera/mike recordings or supplying a video monitor.

Sanyo's V-Cord II model 8200 puts two hours of programming on a $20 cassette. The long-play mode reduces the tape speed by half and skips every other TV picture field (half of the full 1/30-second TV frame). During playback, each recorded field is scanned twice by the heads and electronically woven into a TV "frame" of slightly reduced quality. An optional timer is available for $70. The $1290 8200 has a pause switch that in the playback mode can freeze a single TV frame for extended viewing. The audio track can be dubbed over. Audio/video input and output jacks are provided.



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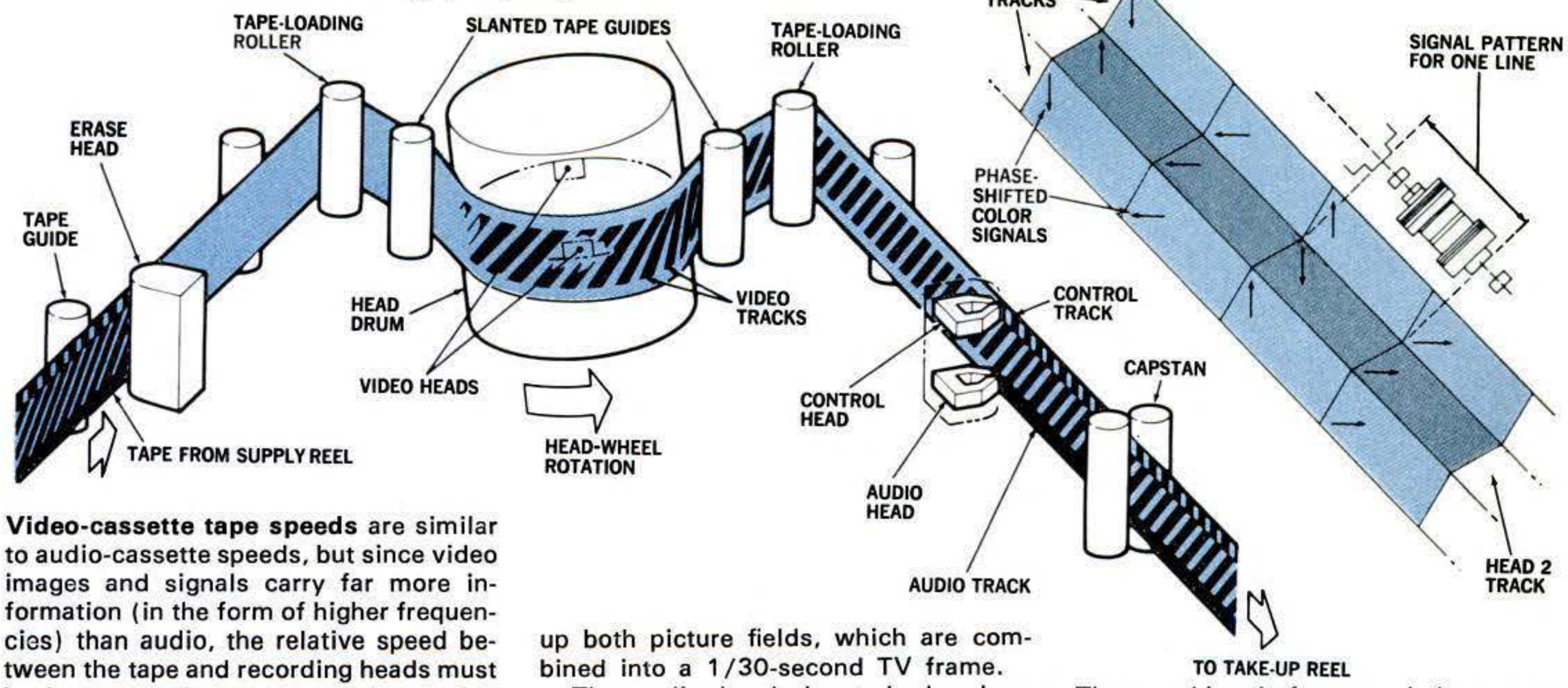
What's recorded on long-play tapes



Video-cassette tape speeds are similar to audio-cassette speeds, but since video images and signals carry far more information (in the form of higher frequencies) than audio, the relative speed between the tape and recording heads must be increased. In most long-play decks, two recording heads are mounted on opposite sides of a drum spinning at 1800 rpm. In this helical-scanning technique, each video head records an extremely narrow track in a long slanted path. Each track is a complete TV picture field (262-plus lines) lasting 1/60 second on your screen. The adjacent track, recorded by the second video head, is another 1/60-second TV picture field. During playback, one revolution of the drum picks up both picture fields, which are combined into a 1/30-second TV frame.

The audio head, located elsewhere along the tape path, records the sound track in a strip along the edge of the tape. A control head records a series of pulses along the opposite tape edge. Control-pulse spacing changes when decks record in the slow-speed (long play) modes. Sensing circuits read these during playback, automatically switching to the proper tape speed.

To achieve high density, video tracks are recorded very close to each other. The guard band of unrecorded tape once left between tracks to minimize interference between adjacent tracks has been eliminated or minimized. Instead, VCR's employ azimuth recording: Video heads are offset from each other so that adjacent tracks have magnetic patterns with a different slant (right, above). Because of this slant, a video head picking up a track signal is practically immune to cross talk from adjacent tracks during playback.

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further, video noise-reduction circuits—similar to Dolby audio noise-reduction circuits—have been introduced. Hook one of these decks to your TV set and you can watch shows you've taped off the air, rented or bought from stores, or created yourself by plugging in a video camera.

The newer VCR's are priced from $1000 to $1300, but competition should trim prices next year. Each company hopes its machine will alter the way you now watch TV—locked into fixed viewing times set by broadcasters. The hard sell you'll be hearing is that home VCR's enable you to:

- Tape one program while watching a separate show on your TV receiver. All the VCR's have built-in VHF and UHF tuners.
- Tape programs while you're sleeping or away by using built-in and optional timers. Many models can record up to four hours—on a single tape for *some* VHS machines, or on two Beta-format tapes with a cassette-changing mechanism. And by next spring, Sony says it will have a three-hour tape (six hours total).
- Tape color or black-and-white shows at home using plug-in cameras. B&W cameras cost less than $400. A $1500 color camera introduced by JVC for its deck is compatible with other machines.
- Watch prerecorded cassettes covering virtually any subject that's now on film. The periodically updated $3 Video Programs/Index (923 6th St. S.W., Washington, D.C. 20024) lists 17 firms offering prerecorded Betamax cassettes.

Marketing experts differ on how quickly home VCR's will catch on, but it's expected to become a multi-billion-dollar industry during the 1980's. Robert Bowen, Zenith marketing vice president, suggests why so many firms are in on the VCR action: "Suppose you said that eventual saturation for the video tape recorder was only 10 percent of American homes. That's 7½ million VCR's."

Most of the VCR capabilities I've outlined have been available for home use since 1975, when Sony introduced its one-hour Betamax machine [PS, Dec. '75]. The big change is the greatly extended record/playback time.

The move to longer playing time began several years ago when the Victor Company of Japan (JVC) began developing a deck designed to record two hours on a single cassette. JVC's two-hour Vidstar Video Home System (VHS), available for more than a year in Japan, was introduced here last summer by U.S. JVC Corp. Hitachi and Mitsubishi (MGA) will also have VHS.

Meanwhile, Sony, with help from other firms, devised a technique to double the playing time of its one-hour Betamax tapes. The newer long-play machines employ Beta-format technology. Sony's new 8200 deck has a switch labeled X1 and X2, for one- or two-hour recording. You can play one-hour tapes from older Betamax decks on Beta-format machines (and vice versa), but only Beta decks handle two-hour tapes. Zenith, Sears, Toshiba, and Sanyo are also marketing Beta VCR's here; Pioneer and Aiwa may join them. Sanyo and others plan to market a two-hour (one speed) Beta model.

But Matsushita, JVC's parent company in Japan, also succeeded in doubling the playing time of VHS cassettes to four hours. This extra-long-play VHS format has been adopted by RCA, Magnavox, GTE Sylvania, Panasonic, and Curtis Mathes. Again, there's compatibility in the VHS family for two-hour tapes.

In addition to Beta and VHS,

[Continued on page 176]

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Projection TV

—build your own for super-size pictures

PHOTOS BY ORLANDO GUERRA

Tilting a curved projection-TV screen slightly directs images toward seated viewers. Brightness drops off sharply if you move horizontally more than about ±10 degrees off axis. Digital light meter (above, left) measured brightness of Extron's Lifescreen I system and other components. The projector top (left), with its mirror, fits over a Sony 15-inch set. Image is 64 inches (diagonally).

New light-enhancing optics can brighten the images beamed from portable TV's in homemade cabinets

By JOHN FREE

A projection TV transforms your viewing room into a mini theater. Tiny human figures, postcard-like outdoor scenes, and the limited expanses of color on standard TV's become immensely more realistic on super-size screens.

Problem is, projection TV's often

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cost from $1000 to $4000 in stores. You can save a lot of that by building a projection TV around your present 12-to-19-inch set. A 50-inch screen and glass lens cost $200 to $240. And recent developments—a large-diameter plastic lens and specially coated extra-bright screens—enhance do-it-yourself systems more than ever.

Recently I tested two projection systems that can be built using plans from Extron and Spearsonic. Based on the test results and three years' experience with my own commercial system, here are points to consider before you convert.

First, make sure you have ghost-free, relatively strong signals. A noisy, multiple-image picture might be viewable on a standard small screen, but it will quickly become unacceptable when enlarged.

Second, if you use your present TV, make sure it's properly adjusted to produce sharp, bright pictures. Newer color models with black-matrix picture tubes work best. Both Extron and Spearsonic recommend a Sony 15-inch model (1541R).

Finally, set up your projection TV in a room that can be completely darkened, or pictures may be too washed out to view by day.

Brightness is crucial. Standard TV screens radiate light in all directions and aren't really designed for projection. Very little light slips through the narrow projection-lens "window" onto a screen. A brilliant 140-footlambert picture on the screen of your small standard set, for example, may be only 0.25 ft-L when projected onto a flat white screen or wall. With a curved light-enhancing screen, that same faint image becomes 2.5 ft.-L—viewable in very low ambient light.

By contrast, some commercial models such as Advent's 1000A use separate red, green, and blue projection tubes that concentrate light. Pictures from the 1000 system exceed 40 ft-L and can be viewed with room lights on.

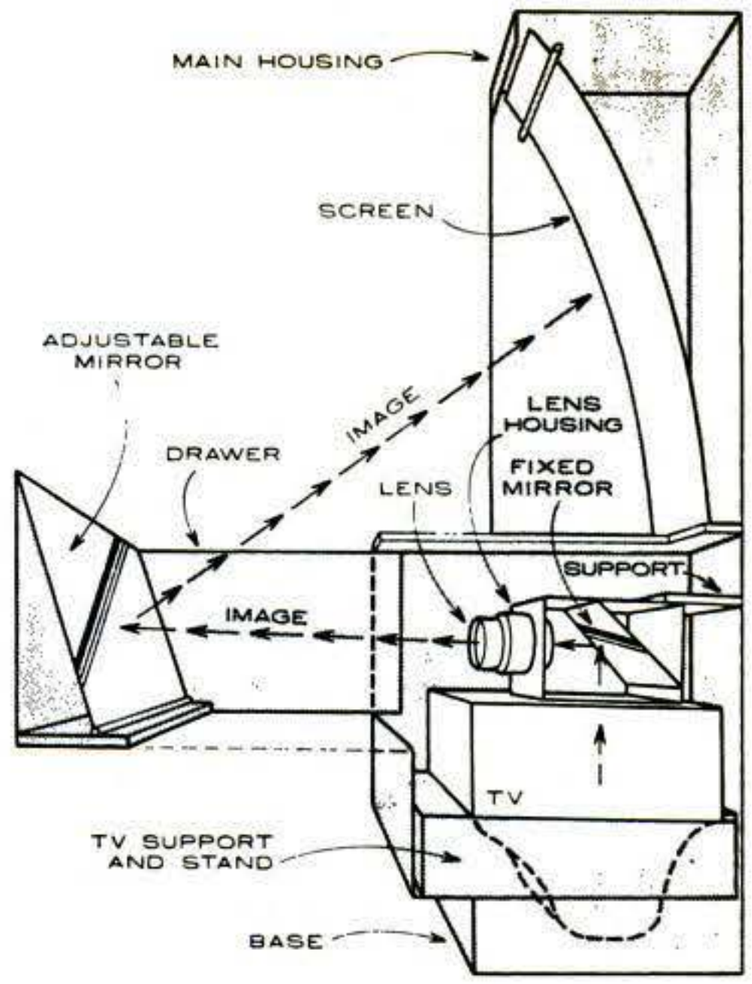
Voltage boosters

To help overcome low light levels from standard sets, some firms offer add-on high-voltage boosters. But Extron, one of the few nationally distributed do-it-yourself systems, stopped booster sales. Michael Rothman, Extron's president, told me the booster was the cause of "blooming"—a blurring of white areas.

A major development last summer was the introduction of a three-element plastic f/1.9 lens by U.S. Precision Lens in Cincinnati. Large lenses with low f-numbers project brighter pictures. A ground and polished glass lens this large (6.5 inches in diameter) would be very costly. U.S. Precision's injection-molding technique, however, reduces manufacturing costs. Extron retails it for $225 as the Tron-Ex.

Using a Photo Research Spectra light meter, I measured image brightness with the f/1.9 Tron-Ex mounted in Extron's Lifescreen I projector with a Sony 1541R and 50-inch (diagonal) screen. The new plastic lens performed better than expected, delivering a 2.4-ft-L image, compared to 0.6 ft-L with an f/3 lens (made by Buhl Optical for Extron). On a 64-inch screen, image brightness dropped to 1.6 ft-L with the f/1.9 lens. The test image was a white rectangle produced by a TV signal generator.

An excellent test for image quality is to examine how well the vertical lines from small-screen striped-phosphor sets can be focused on the projection screen. With the Tron-Ex lens, stripes were in focus to the edge of the screen, but the f/3 lens produced still sharper images. Similarly, in its housing, the four-element f/2.9 lens from Spearsonic produced extremely sharp images.



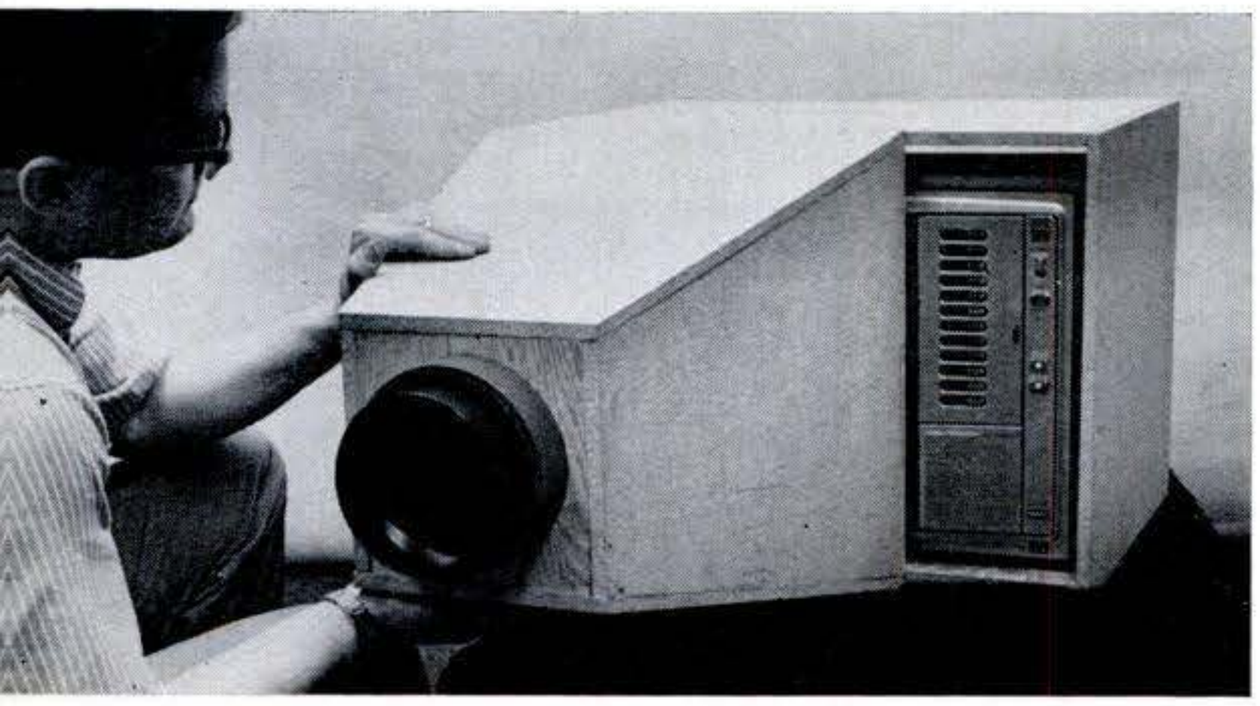
Single-cabinet projection TV uses two mirrors and a slide-out drawer. Plans for Extron's Lifescreen II provide exact dimensions for Sony's 1541R TV.

Two types of flat Fresnel lenses I tested produced poor images. Fresnels are usually large-diameter lenses with closely spaced concentric lines embossed into a surface to focus light. An eight-inch, f/1.6 set from 3M ($119) projected viewable bright images near the center of the screen but had poor focus elsewhere. Objects, especially near the screen edges, had white halos—as though viewed through a fog. Eight- and 10.5-inch-square Fresnels from Edmund Scientific ($6 each) had poor focus and halos, too.

A significant improvement in the curved Ektalite-type screens used with projection TV's took place last summer. Marv Hodges, Inc., of

[*Continued on page 165*]

Projection-lens hood and cabinet (not yet veneered here, to show simple construction) can be built from Spearsonic's plans. You can mount the cabinet in a swivel-type U-shaped floor frame, or suspend it from a ceiling to save space.



Lenses tested included (left to right): Extron's f/1.9 plastic Tron-Ex and f/3 Lifescreen units, Spearsonic's four-element f/2.9 lens, 3M's plastic f/1.6 Fresnel (in a demonstration mount), and two Fresnels from Edmund.

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PS buyer's guide to **turntables**

A look at medium-price units reveals that your dollars buy more performance than ever

By HARRY MAYNARD

Low-line styling and elegant engineering to minimize noise and speed-variation problems characterize the '78 turntable line. Models shown also have removable dust cover.

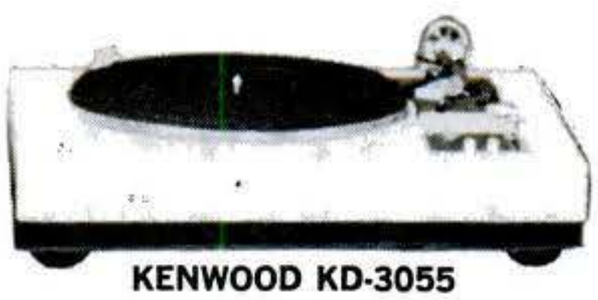
If you're in the market for a phonograph turntable—manual, semiautomatic, fully automatic, or multiplay changer—you're in luck. Today, for $200 or less you can buy performance, convenience, and styling that even professional turntable models couldn't match several years ago.

I've just evaluated 15 representative turntable models priced under $250 from among the 50-odd labels available. With fair-trade laws out, you can usually pay much less than the suggested retail prices we show, by shopping around. I saw one of the $180 models on sale for $120.

To evaluate the machines, I used carefully selected discs, two separate audio systems, and relied on my ears as the final guide. Printed specifications were noted, but these figures can be misleading since at least five different speed-accuracy standards are used. Manufacturers

YAMAHA YP 211

LAFAYETTE T-4000


KENWOOD KD-3055

THORENS TD-166 MKII

PIONEER PL 510A

REALISTIC LAB-300

TECHNICS SL 1800

JVC JL-A40

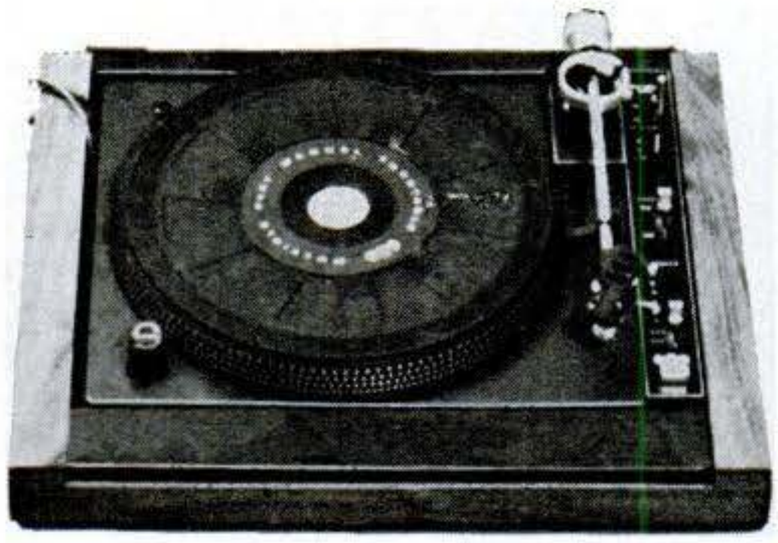
SONY PS-2700

FISHER MT 6225

GARRARD DD 75

PHOTOS BY A. J. HAND

DUAL 1237


BIC 960

ELAC PC 830

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tend to publish standards with the more impressive figures, such as the European DIN system.

In my evaluation of each turntable, I was first concerned with the basic task of a turntable—to rotate the disc at an unvarying rate of speed. There are two practical floors for turntable performance. First, commercial discs generally have a speed accuracy of 0.037 percent (DIN B). Second, there are limits to hearing. Most of us cannot detect speed variations below an average of 0.1 percent or a peak figure of 0.15 percent. Here, the lower the specified figure, the better.

All of our 15 turntables claimed figures as good as this or considerably better. The new direct drives, with their sophisticated electronic servo motors (Technics SL 1800, Pioneer PL 510A, JVC JL-A40, Garrard DD 75, and Fisher MT 6225), all have specified wow and flutter of less than 0.03 percent.

The Technics SL 1800 was typical, in principle, of all but one of the direct-drive turntables. It has a single integrated circuit that replaces the function of 327 separate components; its servo system constantly monitors minute turntable-speed variations, and supplies corrective current for speed accuracy. Direct-drive motors have the obvious virtue of eliminating belts and pulleys and the claimed virtue of easier maintenance. The Pioneer PL 510A uses a brushless motor employing the Hall-effect principle for monitoring speed accuracy—a semiconductor whose resistance varies with the magnetic field impinging on it. Direct-drive motors run at the same speed as the disc, and the platter can be directly coupled to the motor.

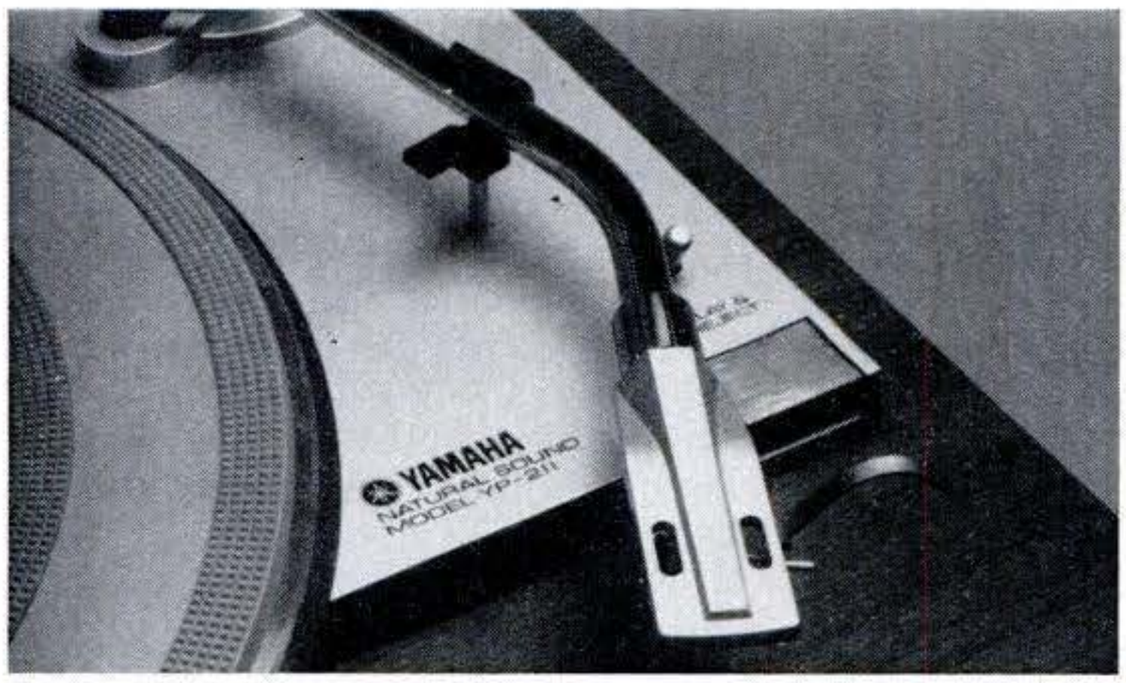
The most unusual of our direct-drive turntables was the Fisher MT 6225, which uses an electrical-mechanical servo system with its 120-pole motor. The Fisher turntable uses the platter as a part of the drive system, and the platter is magnetically rotated by the interaction of a 14-mm motor ring and stator consisting of three field coils for the magnetic drive, servo-speed-control sensors, and three drive-signal sensing coils. The motor ring is mechanically subdivided into 120 sections. Fisher claims this linear-drive system reduces cogging—the push-pull effect of more conventional motors—to imperceptible levels.

Our other turntables all use belt drives—a system that many still say is better and that's generally cheaper to manufacture. Another claim is that belts act as a mechanical filter, reducing the signal-to-noise ratio (rumble) of the turntable. None of these turntables has a claimed speed accuracy of better than 0.05 percent.

I was anxious to compare the auditory difference between the direct-drive models and the belt-drive systems with more modest specifications. For this listening test I used a group of special musical discs (piano and woodwind recordings) whose speed accuracy is within 0.037 percent. Top-of-the-line cartridges were used. Piano and woodwind recordings are particularly good for revealing wow and flutter problems in a turntable. Speed variations in low-end sustained piano notes that show up from six Hz down to ½ Hz are particularly offensive to a trained ear.

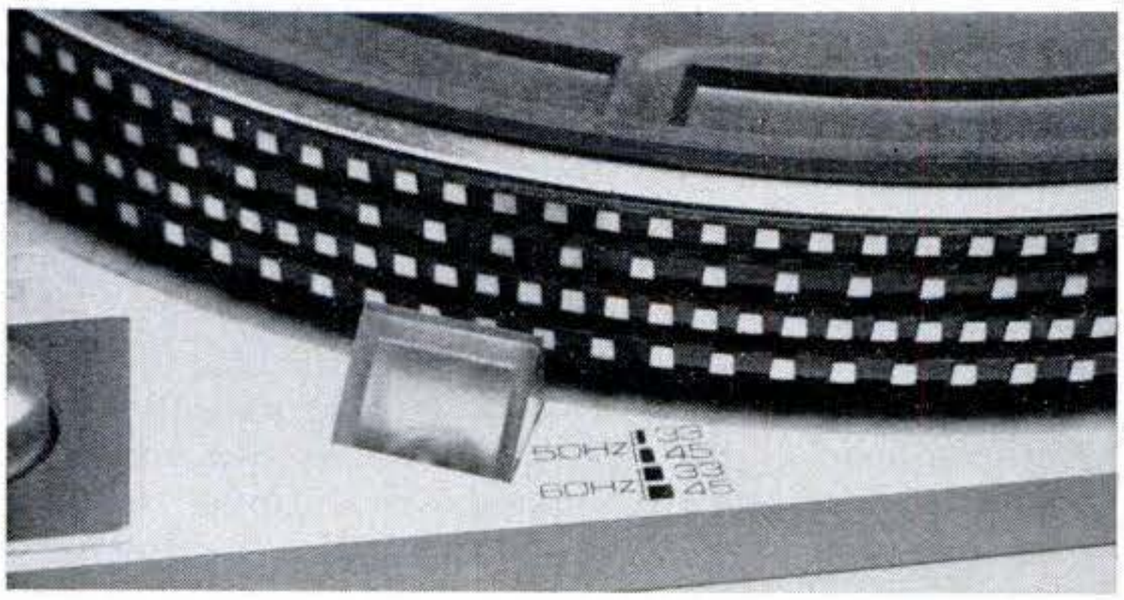
All of our 15 turntables passed this test. I could detect no significant audible superiority of one over another, or between the belt drives and direct drives with better specifications. I also listened for flutter (higher-speed variation), which is even more annoying to most listeners because it gives a rough edge to music.

Continued

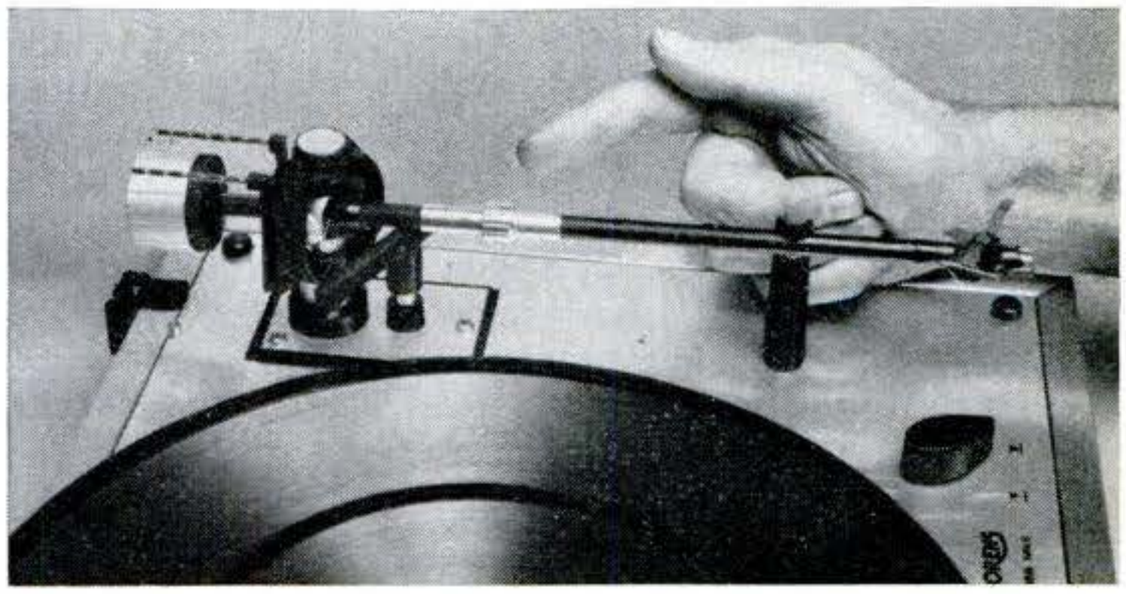


Statically balanced, S-shaped tone arm helps correct tracking error. The removable shell for the cartridge permits quick changes after you loosen the screw collar.

Linear-drive turntable from Fisher (MT 6225) has three electromagnetic drivers (left) that attract and repel 120 poles in a ring of ferrite magnetic material within the platter.



Stroboscopic plates and the built-in light on many models make it easy to check and adjust speed with a pitch control. Four bands register two speeds at 50 Hz or 60 Hz.



Removable tone-arm section for Thorens' Iso-track enables the screw collar to be moved back near pivot; this allows a reduction in counterbalance weight and overall arm mass.

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Buyer's guide to representative 1978 turntables

Name	Model	Manufacturer's suggested retail price	Anti-skate	Removable head shell	Cueing	Automatic features	Pitch control	Strobe	Type of drive/ motor	Features
BIC	960	$160	Yes	Yes	Yes	Multiple play	Yes	Yes	Belt drive; 24-pole, 300 rpm	Isomer-damped tone arm
DUAL	1237	200	Yes	Yes	Yes	Multiple play	Yes	No	Belt drive; 8-pole synchronous	Gimbal-mounted tone arm
ELAC	PC 830	190	Yes	Yes	Yes	Multiple play	Yes	Yes	4-pole AC synchronous	Idler-assisted belt drive
FISHER	MT 6225	250	Yes	Yes	Yes	Semiautomatic	Yes	Yes	Direct drive; 120 pole	Electromagnetic drivers; servo-control sensors
GARRARD	DD 75	210	Yes	Yes	Yes	Auto return-stop	Yes	Yes	Direct drive; DC servo	Push-button controls
JVC	JL-A40	180	Yes	Yes	Yes	Auto return	Yes	Yes	Direct drive; servo motor	Tone-arm elevation adjustment
KENWOOD	KD-3055	190	Yes	Yes	Yes	Fully automatic	Yes	No	Belt drive; 4-pole synchronous	Special anti-resonance base
LAFAYETTE	T-4000	180	Yes	Yes	Yes	Auto return	Yes	Yes	Belt drive; DC servo	Frequency-generator servo circuits
PHILIPS	GA 312	180	Yes	Yes	Yes	Semiautomatic	Yes	Partial	Belt drive; electronic	Electronic auto-stop; electronic speed control
PIONEER	PL 510A	200	Yes	Yes	Yes	Semiautomatic	Yes	Yes	Direct drive; DC servo	Double-floating base
REALISTIC (Radio Shack)	LAB-300	160	Yes	Yes	Yes	Semiautomatic	No	No	Belt drive; 4-pole AC synchronous	Includes magnetic cartridge
SONY	PS-2700	165	Yes	Yes	Yes	Fully automatic	No	No	Belt drive; 4-pole AC synchronous	Air-damped record cushions
TECHNICS	SL 1800	180	Yes	Yes	Yes		Yes	Yes	Direct drive; servo motor	Double-isolated suspension system
THORENS	TD-166 MK II	200	Yes	No	Yes	Semiautomatic	No	No	Belt drive; 24 pole	Iso-track removable tone arm
YAMAHA	YP 211	130	Yes	Yes	Yes	Semiautomatic	No	No	Belt drive; synchronous	Repeat lead-in; reject-shutoff

Next, I listened for rumble caused by the interaction of motor and turntable. Again, I was interested to learn if I could hear significant differences between turntables—particularly between the direct drives and the belt drives. The direct-drive group all claimed rumble figures (DIN B) from −73 dB for the Technics to −68 dB for the Pioneer. The belt drives claimed from −64 dB for the Elac PC 830 to −58 dB for the Yamaha YP 211.

For this assessment, I used piano concerto records with a wide dynamic range that I knew tended to aggravate rumble problems. Again, when playing the belt- and direct-drive systems at moderate-to-loud levels, all 15 turntables performed well.

I had been playing discs on the 15 turntables at a level most people would agree to be loud enough. I was using a $600 receiver and $250 speakers. Now I turned on my high-end system whose $500 speakers can deliver the last bottom octave of sound. A subtle yet clearly perceptible muddiness and haze was now apparent with all 15 turntables. It obviously was a problem of system resonances. Generally, this resonance problem takes place from 10 to four Hz in an interface between tone-arm cartridge, turntable, and amplifier.

As a cure, I tried my older Dual 701. This $400 turntable has specs that are no better than those in our group of direct-drive models. But there is one difference. The Dual 701 has dual mechanical resonance filters located in its counterweight.

Part of the filter minimizes acoustic-feedback problems—sound pressures from the speakers reaching the turntable via an air path or vibrations in a shelf, floor, or table.

With my reference turntable, the 701, back in my high-end system, the resonance problem vanished. Whatever was producing rumble frequencies—even at an inaudible level—was causing annoying haze, or intermodulation effects.

Designers say the trend in turntable design is to eliminate any and all forms of these unwanted resonances entering an audio system via the turntable. An engineer friend of mine went to extreme length to eliminate resonances; he mounted his table in a 200-pound concrete base. Kenwood uses the same approach—to a considerably lesser degree—in the KD-3055 table. This unit attacks the acoustic-feedback problem with a specially molded base made of resin concrete that looks like marble. The KD-3055 works well—even when placed near loudspeakers playing at moderate-to-high levels.

I found other turntables, such as the Pioneer PL 510A, JVC JL-A40, and Technics SL 1800, slightly more immune to jumping, heavy footsteps, and pounding than others in the group. The Pioneer PL 510A has a double floating suspension system inside four rubber feet; the whole turntable floats on springs suspended from the top panel of the base.

The Technics SL 1800 uses a double isolated suspension system that floats on a secondary system. The JVC JL-A40 also shows similar design efforts, using a "parallel isolation suspension" in which coupled rubber dampers and coil springs are used to soak up the shakes, jolts, and jars.

I have discovered that convenience features in a turntable, once you become accustomed to them, have a way of becoming necessities.

Of our multiple-play turntables (as changers are now called), the Dual 1237, BIC 960, and Elac PC 830 gave a good account of themselves. I preferred the Elac PC 830 because it performed as well as or better than the other two and had more convenience features.

All of the turntables had the low-capacitance cables necessary for CD4 and moving-coil cartridges. Each turntable came with a hand-

[Continued on page 181]

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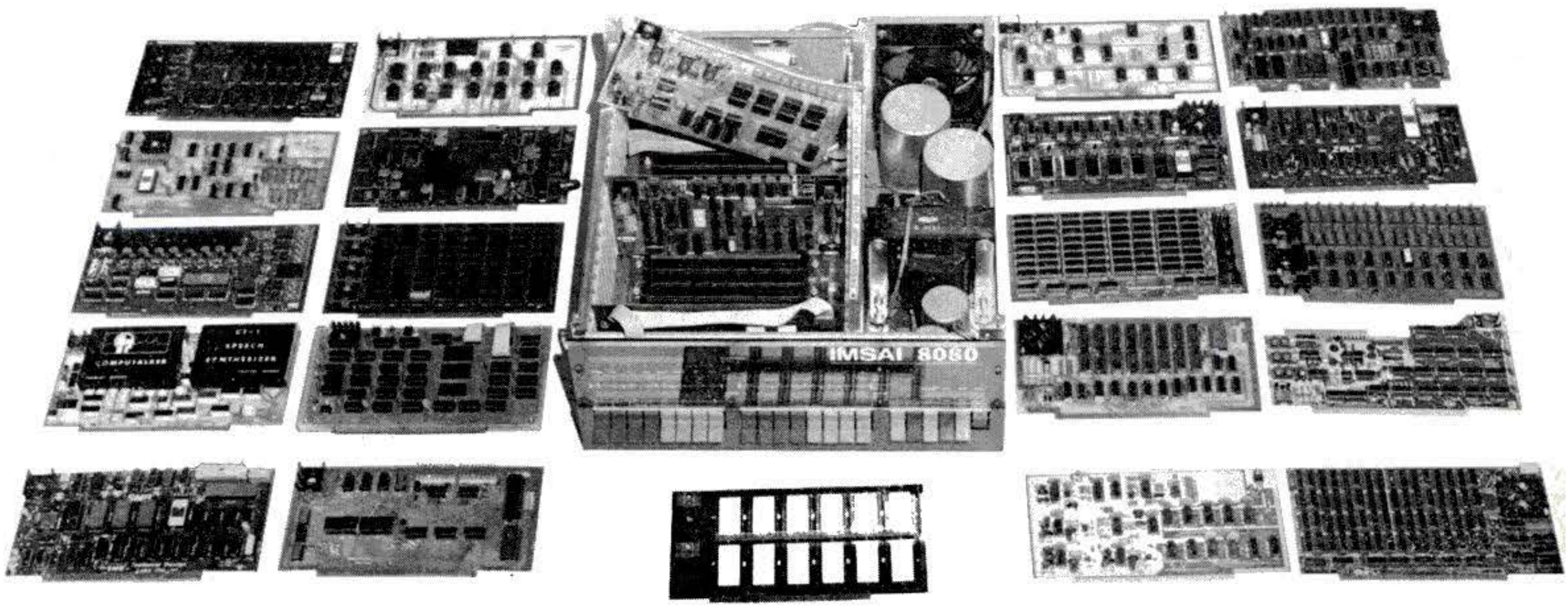
Plug-in circuits

make home computers talk, listen, play music, and more



More than 100 special-job plug-in boards are now available to make home computers more versatile and useful. Typical samples above include (from top to bottom, left to right): Microdesign PROM/RAM, $124; MITS Vector Interrupt/clock, $138; MITS Controller, $165; Computalker Speech Synthesizer, $395; TDL, Technical Design Laboratories, monitor I/O, $295; Canada clock, $98; CompuTime clock, $199; Seals 8K RAM, $295; MiniTerm graphics I/O, $269; National Multiplex I/O, $189. In IMSAI computer: Cybernetic Speech synthesizer, $325; Solid State Music music synthesizer, $250; Vector Graphics PROM, $129. Then, Seals battery backup, $55; Canada controller, $189; Cromeco Bytesaver, $145; Vector Graphics 8K RAM, $275; ECT, Electronic Control Technology 8K RAM, $295; Heuristics speech recognition, $249; IMSAI multiple I/O, $195; TDL ZPU Z-80, $269; IMSAI 4K RAM, $139; Cromeco a-d, $145; Processor Tech 8K RAM, $295.

Build 'em up, plug 'em in—here's how they go together and how well they work

By WILLIAM J. HAWKINS

My home computer plays the "Sesame Street" song to my daughters, talks to my wife, and literally listens to me—recognizing my voice and executing my instructions. It's capable of turning on lights, controlling our burglar alarm, and drawing pictures, and it will even give me the time of day and date. That hulk of transistors has acquired a kind of mechanical personality (my family calls it "Breslin"), and it's ready to do real work around our house thanks to some special printed circuit boards I built and plugged in.

If you're into computers at all, you know that they do almost nothing by themselves. It's the extra "peripherals"—TV terminals, keyboards, teletypes, printers, etc. that allow them to communicate and perform for you. The specialized boards I'm about to describe are peripherals in a way, too. But they live inside the computer and help it do much more than just compute.

They're called S-100 compatible boards. That means they mate mechanically and electrically with the most popular home computers. Each board is capable of doing at least one specific task, but, since many of the 100 or so available are duplicate ideas from different makers, I chose just 24 to build (most are in kit form) and try. As you'll see, nearly all can be built and running in a few hours. A few, however, I'm still trying to figure out. Here's what they do:

Got the time?

If you want the computer to start your coffee in the morning, it's got to know when you get up. For that, there are clock boards. Canada Systems makes one that's well-designed, easy to use, and comes complete with sample programs you can put in and try right away. It will give the time in hours, minutes, and seconds, which you can display or use to execute programs at any interval you wish.

CompuTime makes a more complicated version that contains not only a clock/calendar, but a scientific calculator as well. This makes it a lot simpler to use your computer to solve many complex problems, but programming this board is understandably more difficult and its makers don't supply a complete test package. So you'll need some programming experience to get it working, but building it is easy.

MITS makes a clock circuit as well, but it's part of what in computer jargon is called a Vector Interrupt board. With it, you can assign priorities to outside pieces of equipment (including the on-board clock) so the computer will select the order of jobs to perform based on how important they are. If it's working on a low-priority job when one with a higher priority comes along, it will interrupt the first and start on the second.

Outside control

All your computer can do toward

Continued

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controlling an outside device such as a coffee pot, lawn waterer, or burglar alarm is to generate a signal at a certain output terminal at the right time. But to actually turn the appliance on or off, you need a controller circuit board. For example, a Canada board gives you up to 16 outputs for controlling 16 items. The outputs, however, are just a series of signals; each is a voltage change from zero to 12 volts (no load, five milliamps total) DC. Then you use yet additional circuitry to make the signal do something. Or you can add Canada's optional $52 controller box. That switches up to 300 watts of AC house current for each circuit you're controlling. The Canada system has easy-to-read instructions with complete tests and sample programs. You can have the unit running shortly after you build it.

Another, from MITS, has eight outputs and eight inputs. The outputs on this board, however, are relay-controlled. That eliminates the need for additional circuits. The MITS board is highly versatile, so the instructions on how to make it do all the things it can are lengthy and technical.

Still another type of controller board is the Cromeco a-to-d (analog to digital) convertor; it will convert analog signals to digital, and vice versa. I was skeptical about the usefulness of this board —until I built it and started thinking of things for it to do. It didn't take long to find the first application:

A plastics factory close to my house runs 24 hours a day sucking plastic pellets from two steel silos, operating heavy machinery, and simply making it impossible for me and my family to get a good night's sleep. I called the state environmental protection agency and was told that certain levels of noise at night are illegal. I had been hatching a scheme to collect evidence that I could turn over to the state to get them to crack down on the factory. When I got the a-d convertor, my plan suddenly snapped into place.

I borrowed from POPULAR SCIENCE the sound-level meter we use in our car tests. I hooked this up to the a-d convertor and calibrated the hookup so that the sound levels the meter picks up at my back window are translated into digital signals the computer can understand. Then I programmed the computer so that when the sound level exceeds the legal limits, the computer switches on an audio tape recorder. Thus, later I can tell exactly what the sound was. The computer also turns on the printer and prints out the time, date, duration, and exact level in dB of the offending sound. It also feeds the dB level back to the a-d convertor, which now functions in its d-a mode. The analog signals representing sound level are then fed to a chart recorder, which plots the sound level. The EPA has come out and checked my calibration against its equipment—my computer works somewhat faster. The noise continues, but I'm told the matter will be checked out completely and appropriate action taken soon.

Speak to me

The most exotic and interesting boards are the synthesizers—circuits that electronically produce a human voice or music.

The Cybercom music board, by Solid State Music, for instance, is designed to generate an infinite variety of wave forms and frequencies that, played through an amplifier and loudspeaker, can create serious music. While there are different ways to program it, the easiest is to use the program the company supplies—it accepts characters from your keyboard and interprets them. For instance, "4HC" is a half note, the pitch of which is C in the fourth octave within the system's range. By stringing these symbols together, you can create your own music. I got help from a musically inclined relative to program the "Sesame Street" theme song for my daughters, but, with practice, anyone can learn to use the board easily.

The program is designed to control up to eight music boards so that serious composers can create complex music. Building it is difficult since the components are not marked on the board and the company supplies only a hand-drawn rough sketch for parts placement. With patience, however, it all goes together well.

Reactions in my family to the speech boards—ones that actually talk—ranged from eerie to hysterical. To hear your home computer say "hello" for the first time makes you take a second—very hard—look at the glimmering lights.

Two companies, Cybernetic Systems and Computalker, offer talking boards in prebuilt versions only. Both are programmed by typing in, using phonemes—the spelling of a word by the way it sounds. "Computer," for instance, is "ka-ampyuwter" in phonetics. The programs supplied with both systems make them fairly easy to use (the trick is learning all phonetic spellings), but there's a big difference in the way they sound.

Unfortunately, the Cybernetic Systems board is very difficult to understand. Some of the instructions are aimed at teaching you the new form of speech—a bit illogical since, I presumed, the idea was for it to talk my language. Also, the board is not electrically switched off after giving its message—treating you to an irritating hiss between sentences.

The Computalker, however, is much different. The program supplied for checkout is a trade-off between ease of programming and minimum of memory space required. (It can also be set to use more memory if you want it to speak even more realistically.) While not every word I have it say comes out sounding like Clarence Darrow, its overall clarity is remarkable. A complete program listing is supplied in the instruction book (computer buffs call it the documentation) and on paper tape. Although it's expensive—$430—the fun you'll have and the unique addition it'll make to your system make it worth every "ssnnt."

Another type of speech-processing board, from Heuristics, listens rather than talks to you. First, you speak certain numbers and letters into a microphone while simultaneously punching them into a keyboard. The computer program analyzes your speech in several ways (frequency, duration, and so on) and stores the information as a series of digital numbers. It then correlates them with the numbers and letters you type in simultaneously. When you're ready to use the program, you speak again into the microphone. The program analyzes the sound in the same way as before, then compares the string of digital numbers with those in the memory. It finds the closest match, then prints out the number or letter it associates with that digital pattern in its memory. It's not perfect, but once programmed completely, its designers say, it will be right about 90 to 95 percent of the time. And, of course, it could handle whole words in addition to letters and numbers.

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Heuristics supplies enough information on the programming techniques and the human voice to satisfy a computer-programming throat doctor—I haven't finished reading the first 200-page, loose-leaf-size book. But, from all indications, it should prove to be a very interesting programming project.

Memories

You can't do any specialized jobs with your computer without memory capacity. Your computer comes with maybe 1K (1024 bytes of memory; a byte is eight bits and forms the basic computer "word," and is thus the basic measure of memory). But some special programs may require 8K (8192 bytes) just to run. So you need extra memory to support your programs. I built several of the memory boards on the market. For example:

The IMSAI has 4K of memory—all the others have 8K. But while most 8K units cost $295, the IMSAI costs just $139. Thus, if you're not loaded, you can build up memory in 4K rather than 8K increments.

The easiest memory to build is the ECT 8K board. It uses double-capacity IC chips (4200 RAM—random access memory), so there's much less to assemble. The instruction manual is extremely clear.

For a computer to find a certain piece of stored information, each byte in the memory has what is called an address—a code identifying its location. To assign such addresses and give them to the computer, you usually have to figure out from a set of tables that comes with the board which jumpers to add or which switches to throw. It's complicated.

With the Seals memory board, there are eight built-in switches. But each represents an 8K step up in address. It's easy to remember, and you don't go through the usual process of using the complicated addressing tables.

A power failure can wipe out information stored in memory boards. Seals has a cure for that with a battery backup board. It will work with most memories that have a backup provision. Batteries are not included in the kit.

The Vector Graphics 8K board is the most economical memory, since the board is *preassembled* and tested and costs $20 less than the other kits. That's a good deal, but its makers recommend that it be well ventilated by being at least 1½ inches from other boards in the computer (2 slots) or it could overheat. Be prepared to install a fan.

If you're looking for features, look at the Processor Technology board. It's got everything from battery backup provision in case of a power failure to shadow (more on this later). A complete trouble-shooting guide including long- and short-form test programs guarantees an operable unit when you're done. Documentation and hardware make this a quality memory board.

Another type of memory uses EPROM's (erasable programmable read-only memory). These special chips are designed to retain their programs even after the computer has been switched off.

Let's say you want to store BASIC, the most popular computer language, which lets you converse with your computer in something approximating the English language. The Cromeco Bytesaver board will let you store (called "blowing") the BASIC program in EPROM memory. Then, within a second, an included program will allow you to transfer all pieces (up to 8K) of information down into standard memory so the computer can use it. Cromeco makes building and using this board simple and easy. And, if you order an EPROM (2704 or 2708 types) with it, Cromeco supplies the "blowing" program on the chip.

Along the same lines, Microdesign offers an EPROM/RAM board kit, which holds up to 8K in EPROM and also 1K on standard memory chips that have a shadow function. With shadow, you can program the board to make a particular piece of memory EPROM or RAM. In a way I won't try to explain, this actually lets you get double duty out of the same memory space. Also, you can make another memory board work with it as long as it has the shadow function (such as the Processor Tech memory).

If you ever change your mind and want to erase the info stored in an EPROM, you can do it by exposing the chip to high-intensity ultraviolet light for 15 minutes. There are special boxes designed for this purpose, priced over $100. But I built my own with a kit of parts from Williams Electronics for just $16.75.

Input/output boards

When you buy a computer, it comes with a CPU—central-processor unit—and some small amount of memory. But if you want to talk to it with a teletype, you've got to *get* a teletype. And if want it to print out its replies on a TV screen, you've got to supply that, too. But you need even more. You've got to have a board that can convert the electrical codes into signals that will make the right letters appear on the TV screen, for example, or let the computer know which button's been pushed on the keyboard. These boards are called I/O's, or input/output boards.

IMSAI's new MIO board, for example, is a particularly versatile example of an I/O. It can handle almost any type of signal. In addition, it has about 40 jumpers that can adapt it to just about any peripheral with any type of programming. It's easy to build, but, understandably, its overwhelming versatility makes it hard to set up at first.

National Multiplex also makes an I/O board with built-in program on PROM's (same as EPROM's, but not erasable) to allow easy control of the computer without doing initial programming. The board accepts a TV or TTY (teletype) terminal and is specifically designed to run the National Multiplex magnetic tape system. Although it lacks detailed building instructions, explanations of *how* it works are very complete. Since it runs a tape system at unusually high speed, it's an excellent system for storing programs on tape quickly and easily. For example, it takes 40 seconds or less—not 15 minutes—to load an 8K BASIC program.

MiniTerm makes the Merlin graphic I/O board. This, too, has its own preprogrammed system to run the computer, but its input is just

[Continued on page 168]

MANUFACTURERS' ADDRESSES

Canada Systems Inc., Box 516, La Canada CA 91011; **Computalker Consulting,** Box 1951, Santa Monica CA 90406; **CompuTime,** Box 417, Huntington Beach CA 92648; **Cromeco Inc.,** 2432 Charleston Rd., Mountain View CA 94043; **A.I. Cybernetic Systems,** Box 4691, Univ. Park, Las Cruces NM 88003; **ECT,** Electronic Control Technology, Box 6, Union NJ 07083; **Heuristics Inc.,** 900 N. San Antonio Rd., Los Altos CA 94022; **IMSAI,** 14860 Wicks Blvd., San Leandro CA 94577; **Microdesign,** 8187 Havasu Circle, Buena Park CA 90621; **MiniTerm Assoc. Inc.,** Box 268, Bedford MA 07130; **MITS,** 2450 Alamo S.E., Albuquerque NM 87106; **National Multiplex,** 3474 Rand Ave., So. Plainfield NJ 07080; **Processor Technology,** 6200 Hollis St., Emeryville CA 94608; **Seals Electronics,** Box 11651, Knoxville TN 37919; **Solid State Music,** 2102A Walsh Ave., Santa Clara CA 95050; **TDL Systems,** Technical Design Laboratories, 1101 State Rd., Princeton NJ 08540; **Vector Graphics,** 790 Hampshire Rd., Westlake Village CA 91361; **Williams Electronic Supply,** 1863 Woodbridge Ave., Edison NJ 08817.

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Digital tuners

–breakthrough or gimmick?

Digital readouts are among the numerous features of these top-end tuners. At left, from top, are Setton control console, Sequerra, Scott 433, Heath AR-1515 kit. In rear, from top, are Lux 5T50, Scott T33S, Heath AJ-1510, Toshiba ST-910, and Sherwood Micro CPU.

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For on-the-mark tuning, these devices help you find your station instantly

By DAVID HOOVER

Pop a preprogrammed card into one of these new digital tuners and it instantly selects your favorite FM station. Or push a button on another; silently and electronically it scans up or down the FM band looking for stereo music. And, in case you can't remember channel numbers, there's a tuner that remembers a station by its call letters—automatically displaying the letters when you tune it in.

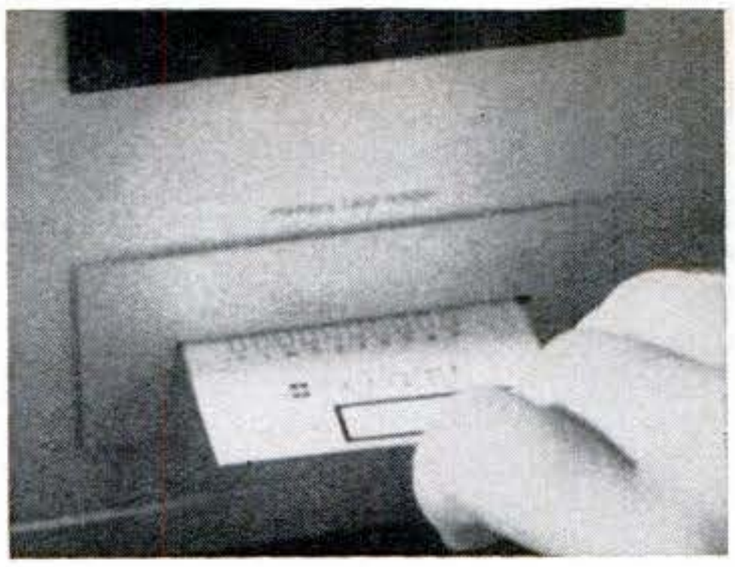
These new tuners and receivers are called "digitals" because they don't have slide-rule pointers. A digital display reads out the frequency in actual numbers to within 0.1 MHz. But that's not all. They also provide new methods of tuning and provide a variety of special features you won't see on conventional units.

There are two types of digital tuners. One uses standard tuning techniques and then displays the frequency it is tuned to digitally. In others, the frequency selected is actually digitally synthesized. This means that a sophisticated electronic circuit—usually a phase-lock-loop (PLL) circuit—creates, or synthesizes, the correct operating frequency. The synthesizers lend themselves to exotic "tuning in" techniques. But standard tuning circuits can also be accurate. And both methods, of course, provide for a digital readout of the frequency being received.

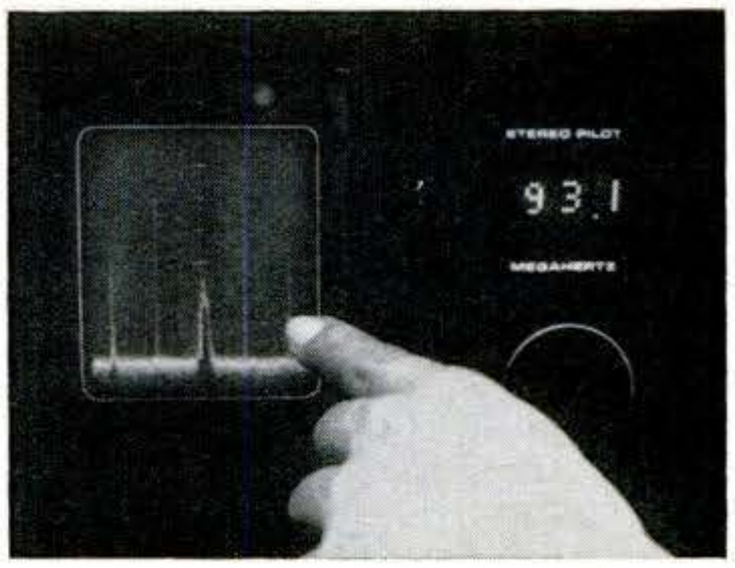
Standard tuning—but digital

A typical standard digital tuner is the SAE VIII. It has the usual tuning knob, but the frequency it is tuned to is shown in a large LED (light-emitting-diode) display. As you turn the dial, the display follows, in 200-kHz (0.2 MHz) steps, up or down the FM band.

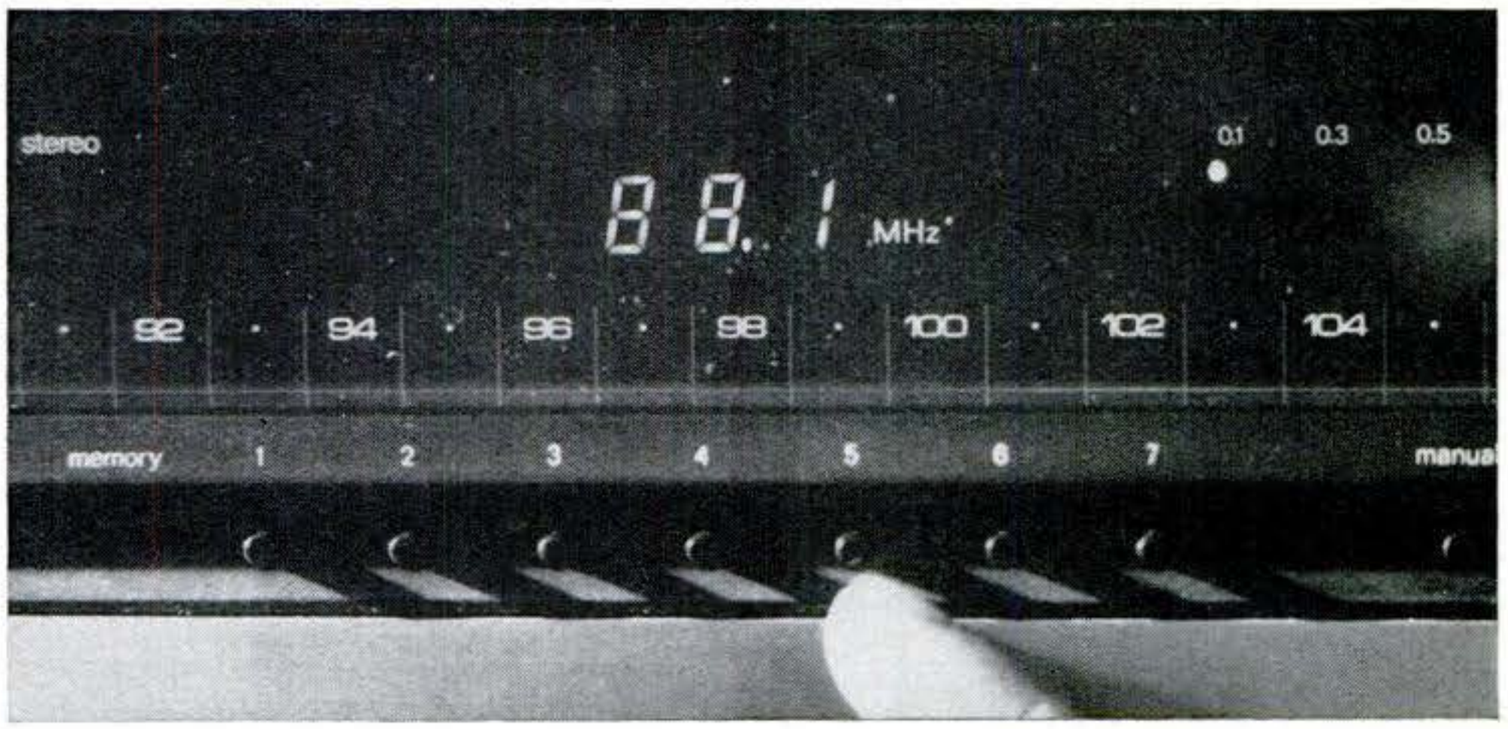
Another unit, Heath's newest 1515, is not a tuner—it's a receiver with a built-in 70-watt-per-channel amplifier. In this unit, the LED digital channel readout steps up or down in increments of 100 kHz (0.1 MHz) as you turn the dial, making it usable for European as well as American broadcast standards. (Stations here are assigned only odd frequency numbers such as 101.5 and 101.7). In Europe, stations can be separated by just 100 kHz. The $550 Heath comes in kit form only, including a 265-page assembly manual. It's a good buy.



Quick and easy way to tune to a particular channel on Scott unit is to insert a punched card. A paper-punch tool, supplied, allows you to program any number of cards for a specific frequency—the unit instantly tunes to it.



Cathode-ray tube (CRT) on the Sequerra displays FM or audio signal. Here, in the "panoramic" mode, the center peak is the station being received; peaks to the side are other stations broadcasting within one MHz of it.



Tune in a station and push one of the memory buttons on this Lux 5T50—you have just programmed it for instant selection of that channel when you push the button again. Up to seven frequencies can be stored at once.

The Sequerra Model 1 also uses a standard dial and digital display for tuning, but that's where the similarities between it and other tuners end. Built into the face of the unit is an oscilloscope that displays every aspect of the FM signal (see photo at top right).

Push a button, for example, and the display produces a fine line with peaks to indicate the station frequency to which you are tuned as well as every other station transmitting within one MHz of it. Used as a vector display, it will show the separation and phase characteristics of a stereo broadcast on an X-Y pattern. Or, you can plug in the output of your four-channel amp and the display will show the separation of each channel in an X-shaped trace. And, of course, the display can be used to help you tune in stations more precisely. The Sequerra probably has the distinction of being the most elaborate FM tuner you can buy; at $3000, it's probably the most expensive, too.

Synthesizers

A synthesizer circuit lends itself to all kinds of tricky tuning techniques. For example, Scott, the original digital-tuner maker, offers both the T33S and the newer 433. With these models, you press a STEREO button, then SCAN, and the unit automatically tunes to the nearest stereo station, showing the frequency on two Nixie tube displays. You can also tune any number of preselected stations by shoving one of a series of punch cards into the slot on the front panel.

Specs on the T33S are a bit better than on the 433; the T33S will tune in increments of 100 kHz rather than only odd frequencies, as does the 433. But the small improvements are expensive. The T33S costs $1000; the 433 is $550.

Another early entry in the digital market was the Heath AJ-1510, and it is still a one-of-a-kind tuner. Any station on the FM band can be tuned by punching in the frequency on calculator-like keys. The numbers appear on the LED frequency display as you enter them. Or, as on the Scott, you can instantly tune the $520 unit with factory-provided punch cards.

If you like indicator lights, you'll

[Continued on page 172]

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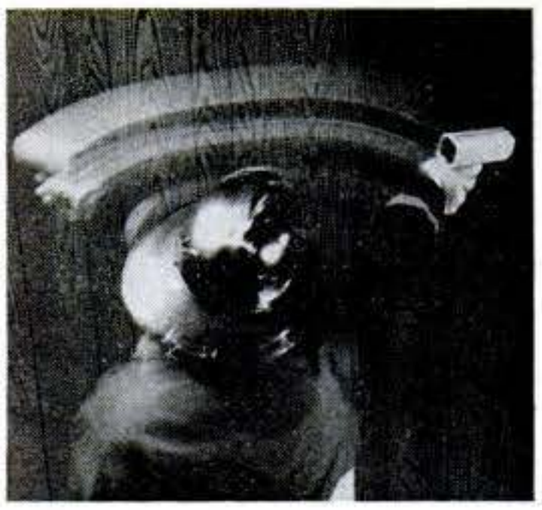
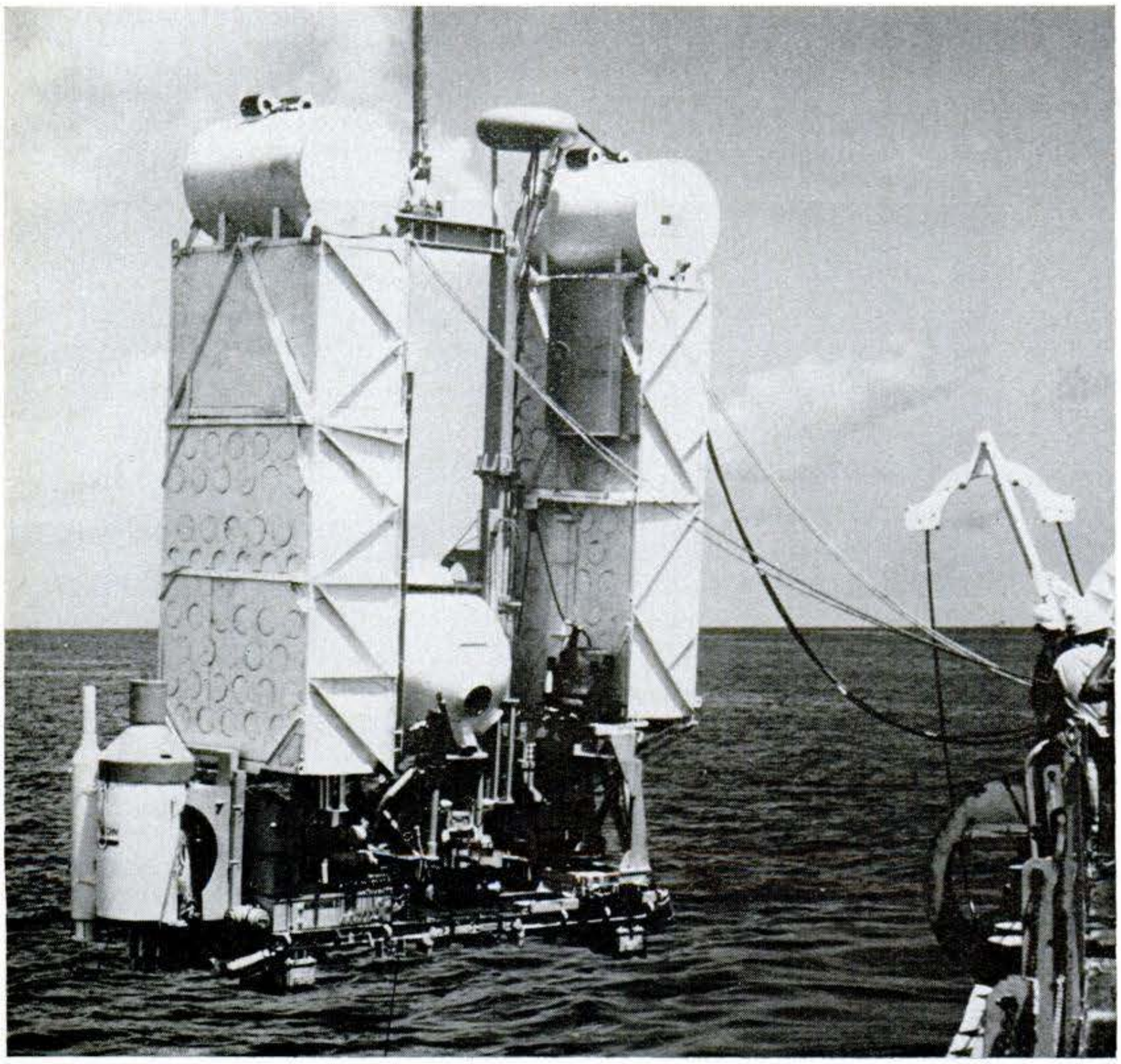
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Fire detector

By sweeping the Heat Scanner across a wall, a fireman can check for hidden blazes. When the solid-state, battery-operated unit detects infrared radiation, a red light on its back signals hot spots. The lightweight device is made by 3M Co. Price: $425.



Robot diver fixes oil wells

This deep-sea diver needs no scuba equipment. It's a remotely controlled "maintenance manipulator" that services Exxon's new Submerged Production System off the coast of Louisiana. SBS, a set of pipelines and remote-control cables anchored to a sea-floor structure, has been producing oil since February. The manipulator helped assemble the system, and now maintains it. To go on a service call, the manipulator descends 170 ft. to the sea bottom, where it rides on a track around the SBS unit. Built-in TV cameras let the surface operator monitor and control the robot as it replaces equipment.

New subcompact

The latest challenge to the Ford Fiesta in Europe comes from Chrysler. Its new British-built Sunbeam, a 12.5-ft.-long hatchback, has a conventional chassis with rear-wheel drive. It features an economical 42-hp overhead-cam aluminum engine and a 42.7-cu.-ft. cargo capacity.

Super copters

A trio of ordinary choppers? Not so, says Sikorsky. These S-76 prototypes are the first designed especially for commercial use. Features include a rotor-vibration absorber; tough but light titanium/fiberglass blades; and maintenance-free elastomeric bearings.

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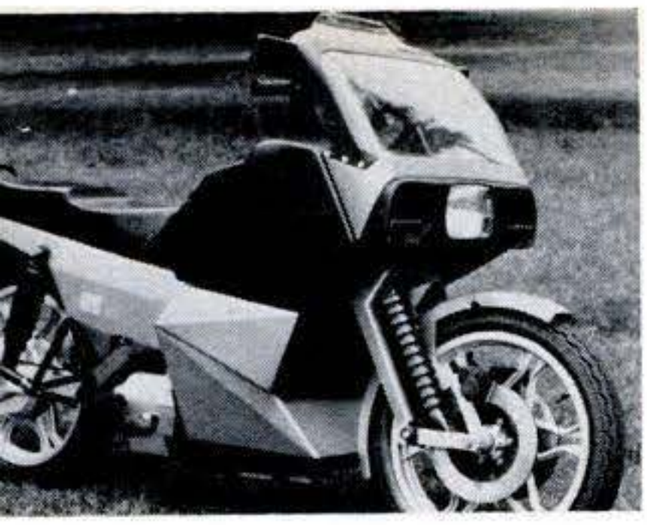
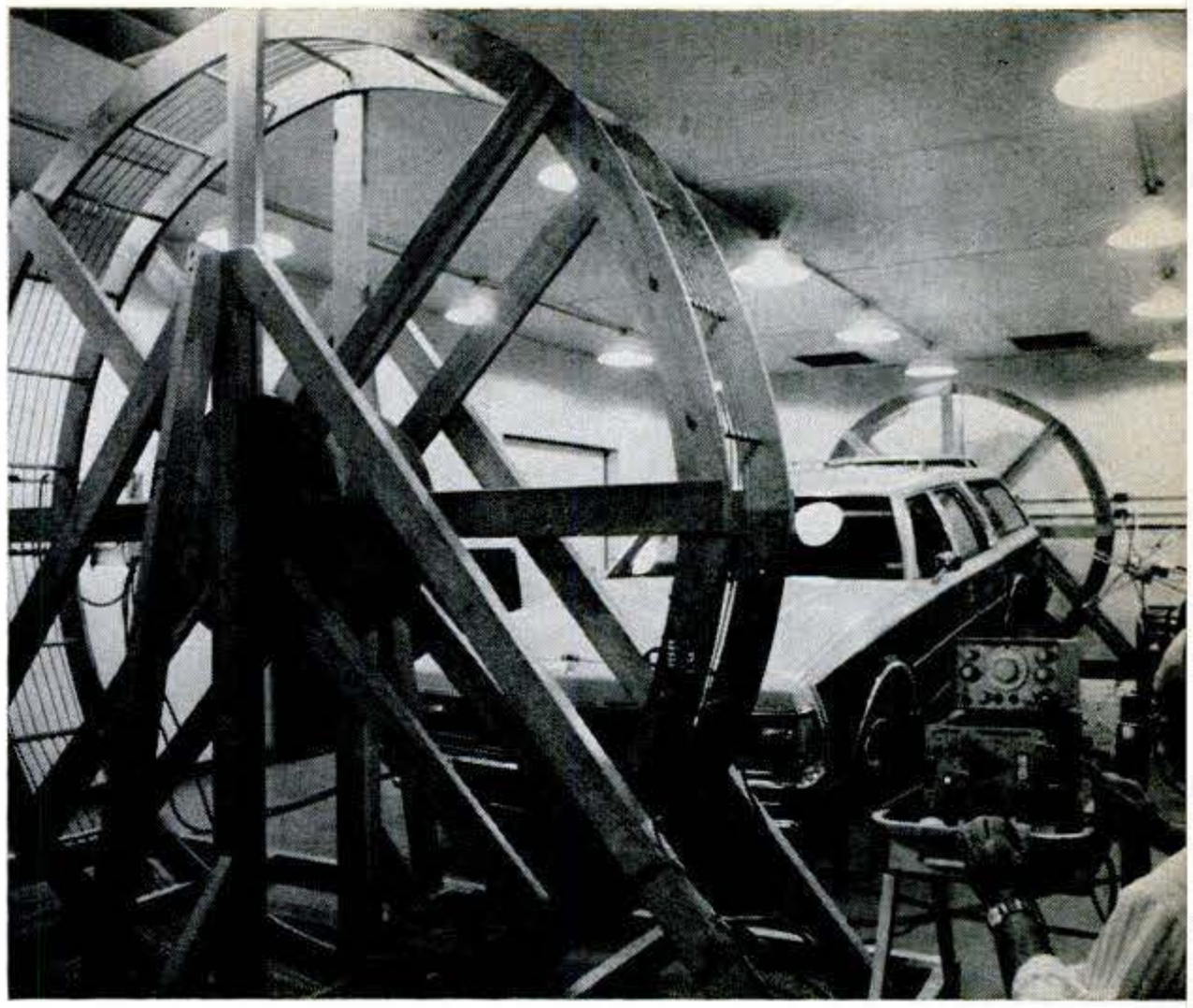


Safer cycle

Tomorrow's motorcycle? This prototype, designed by British students, stresses safety and convenience. The gas tank is under the seat to minimize fire hazards, and the windshield snaps off on impact. A stepped seat offers better driver support; side panniers are for storage.

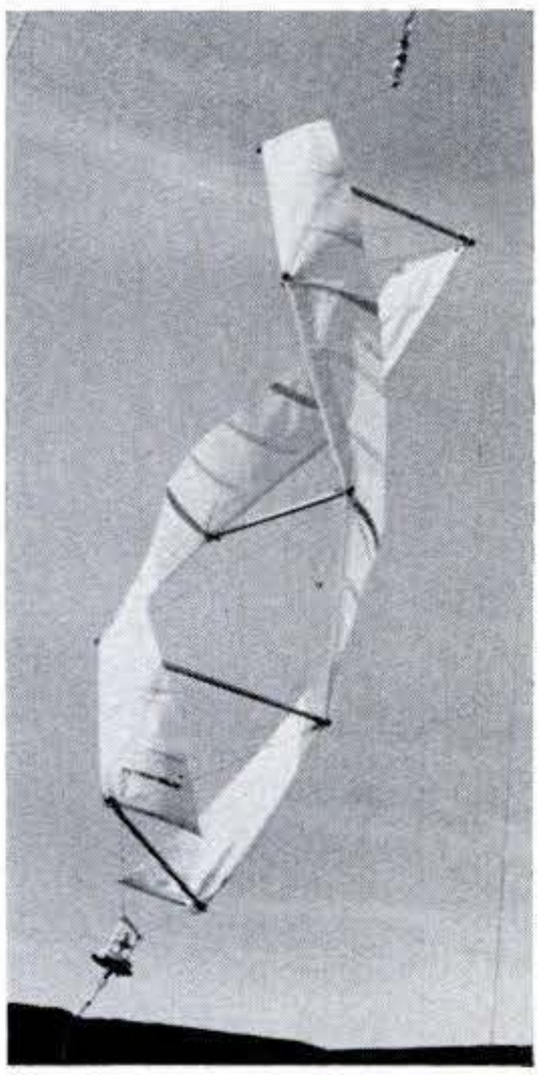
Snow trailer

You can tow it on skis behind a snowmobile in winter, or put a pair of wheels on and turn it into a garden tractor-trailer. The Carry-Boose has a 10-cu.-ft. capacity. It's made by Bombardier Corp., Box 6106, Duluth, Minn. 55806. Price is $139.95.



Electronics testing center

It's an electronic torture chamber for this station wagon mounted between two Helmholtz coils. The giant electromagnets can generate a 60-cycle magnetic field to simulate "real world" conditions—the kind your car faces when you travel a road bordered by utility power lines. Engineers at GM's Technical Center use the coils to test automotive electronic systems. If not properly shielded, the systems could be damaged by electromagnetic interference. GM engineers also make sure the auto's electronics are not generating harmful fields into the surrounding environment.

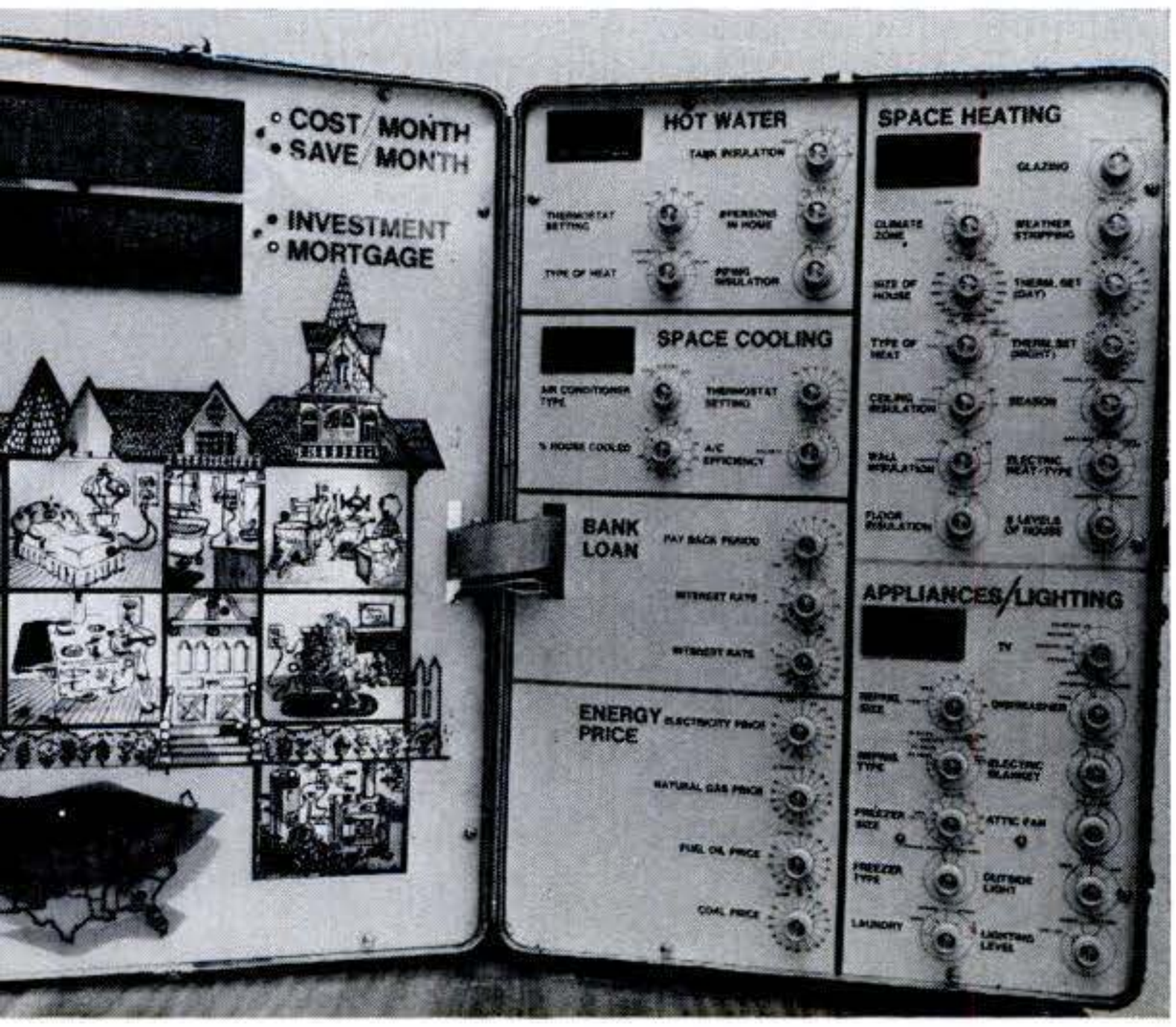


Wind dynamo

Let the wind recharge your battery on a boat or at home. The Tetrahelix S, two sails twisted about a collapsible frame, has its own alternator. It's self-starting in eight-mph winds, and trickle-charges batteries, says Zephyr Co., Box 241, Brunswick, Me. Price: $249.

Advanced bizjet

The "fat engine" look of Rockwell's new business jet is due to its Garret turbofan engines. The Sabreliner 65 also sports supercritical wings for increased speed. The plane's design, a first for U.S. executive jets, gives the craft nonstop transcontinental range.



Home analyzer

This "dollhouse" is really a computer. Punch in data on your home's energy use, and it suggests money-saving strategies. The Home Energy Conservation Demonstrator was developed by Oak Ridge Associated Universities, Box 117, Oak Ridge, Tenn. 37830.

Sniffing autos

Detectors under car bumpers can sniff out gas leaks in underground pipes. Air sucked in is mixed with flammable gas in a rooftop lab and burned in flame-ionization equipment. Danger spots are automatically recorded. Eastern Gas, Potters Bar, Herts EN6 2PD, England.

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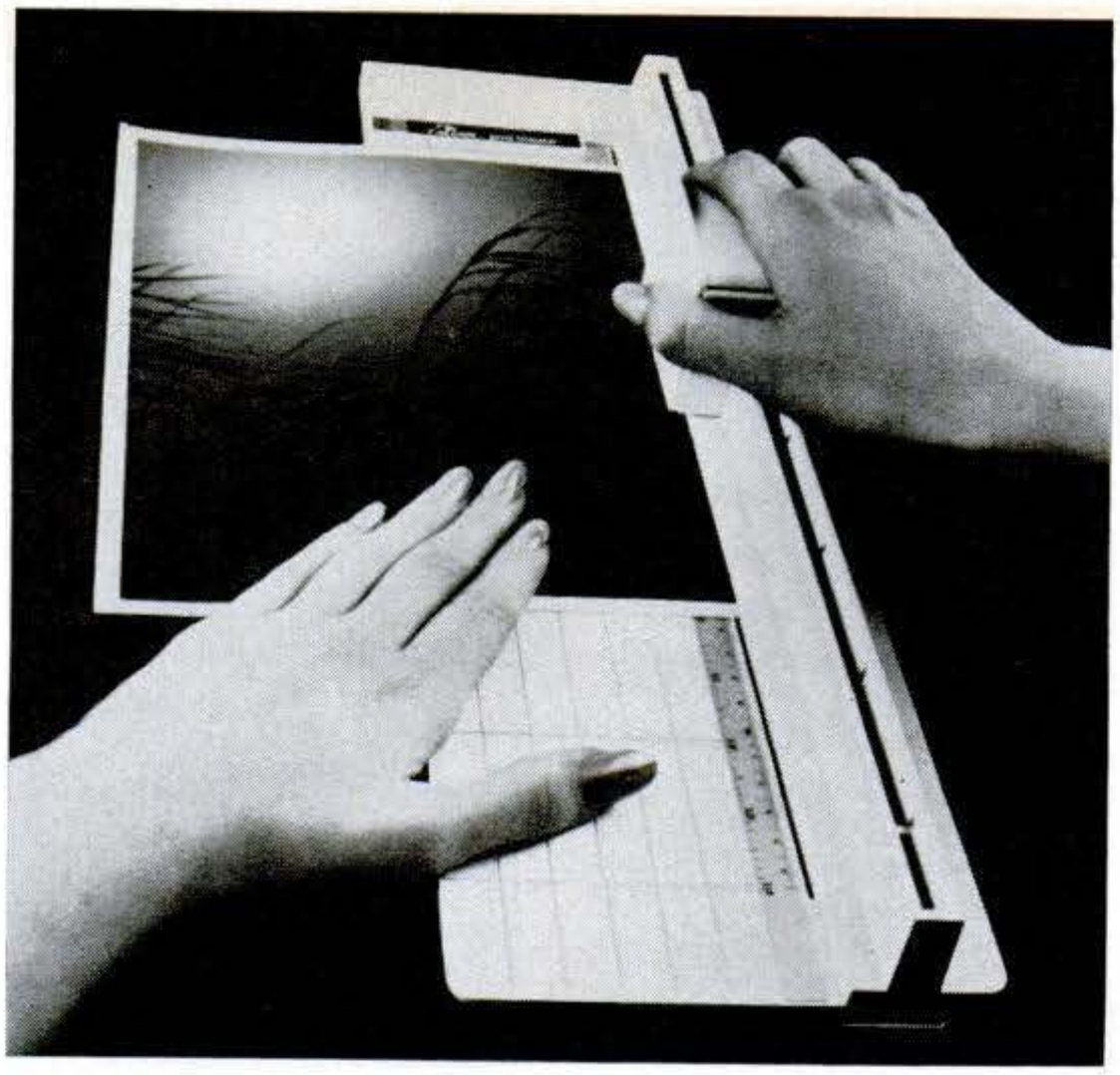
What's New IN PHOTOGRAPHY

By E. H. ORTNER



Sharp trimmer

You always have a sharp cutting edge on the Falcon 14-in. print trimmer—it uses a replaceable single-edge razor blade, enclosed for safety. And the design gives you an unobstructed view of the print being cut. Price: $19.95. Maker: Falcon Safety Products, Mountainside, N.J. 07092.

Dark secret

Camera trouble that needs a light-tight chamber? There's one built into the CarryAll Supreme bag: Two light-proof sleeves convert an outer pocket into a changing bag. The heavy-duty vinyl bag is $16.95 from Spiratone, 135-06 Northern Blvd., Flushing, N.Y. 11354.

Instant flash

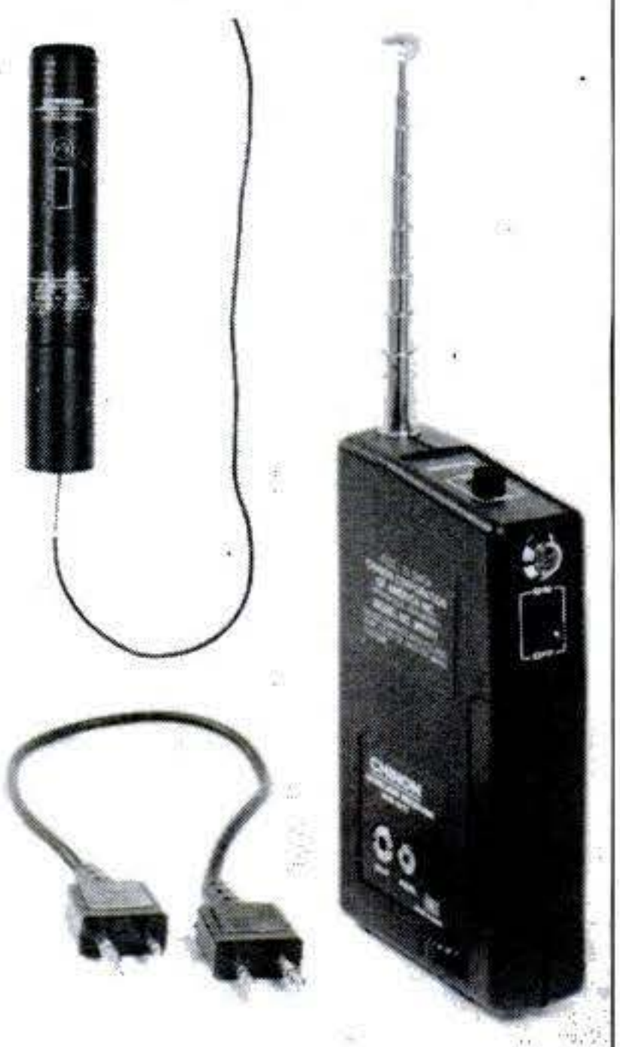
Now Kodak has electronic-flash units for its instant-picture cameras: Model B (far left) for EK4 and EK6 cameras, Model A for The Handle. Both are automatic, quenching the light when exposure is right. Four AA batteries provide more than 100 flashes. It's $32.50.

Painless strap

There's no pain in the neck with the Foto 2001 camera strap; clipped to your belt, it distributes weight across your shoulders. The one-camera model is $9.95; two-camera model, $16.75. EPOI Photo Products, 101 Crossways Park W., Woodbury, N.Y. 11797.

Wireless movie mike

Record voices up to 66 ft. away with your super 8 sound camera? Yes, with Chinon's wireless mike-and-receiver system. The mike weighs eight oz. and operates on a frequency of 49.089 MHz. The receiver, with 21-in. antenna, plugs into the camera's normal mike receptacle. The units are $60 each.



Precision flash

From close-ups to 21 ft. away, the Toshiba ES-36 flash gives ultra-precise light control. Its Toszoom dial meters energy (1/4, 1/2, 3/4, or full) to the automatic thyristor circuit for guide numbers (ASA 25) from 7.4 to 59. For multiple flash, the ES-36 mates to the Toshiba E-40, controlling both. $169.95.

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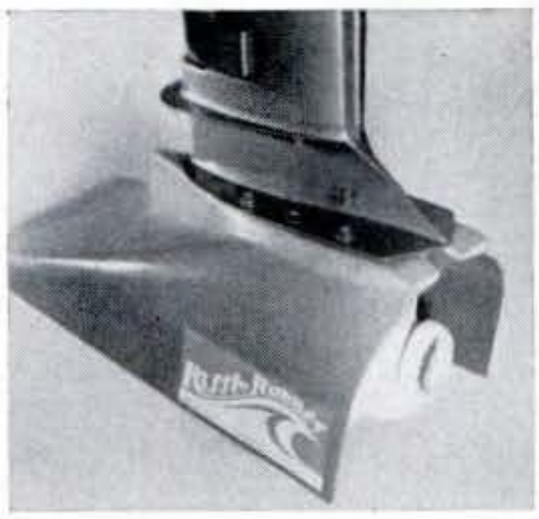
What's New IN BOATING

BY SUSAN RENNER-SMITH

Chart reader

Tired of unrolling bulky charts? The Latady Microview stores up to 45 microfilmed charts that you read through its high-resolution lens. Each 35-mm strip holds about 10 NOAA charts. A strip is $10; the Microview, $100. Latady, Box 39, Accord, Mass. 02018.



Prop protector

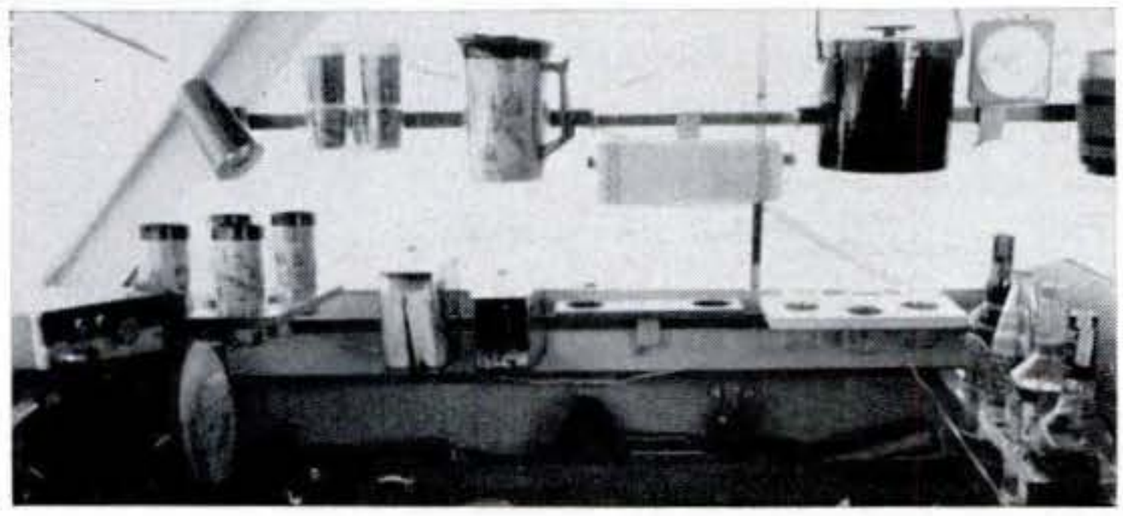
Cruise through shallows with less fear of breaking the prop: The Riffle Runner, a fiberglass scoop, draws water up to the propeller, letting you raise the motor above normal transom height. It's $199 from Water World, 909 S.E. Stephens St., Roseburg, Ore. 97470.

Spinning saucer for TV antenna

If you spot a flying saucer on the horizon—relax. It's probably RCA's dual-voltage model of the Mini-State antenna. The UHF-VHF antenna, housed in a polyethylene "radome," can pick up—and amplify—TV signals from 35 miles away. A remote-control, hand-held unit lets users rotate the antenna to get the best reception for each station. The antenna works off your boat's (or rec vehicle's) 12-volt DC circuit, or off the 120-volt AC at dockside. Price: $100.

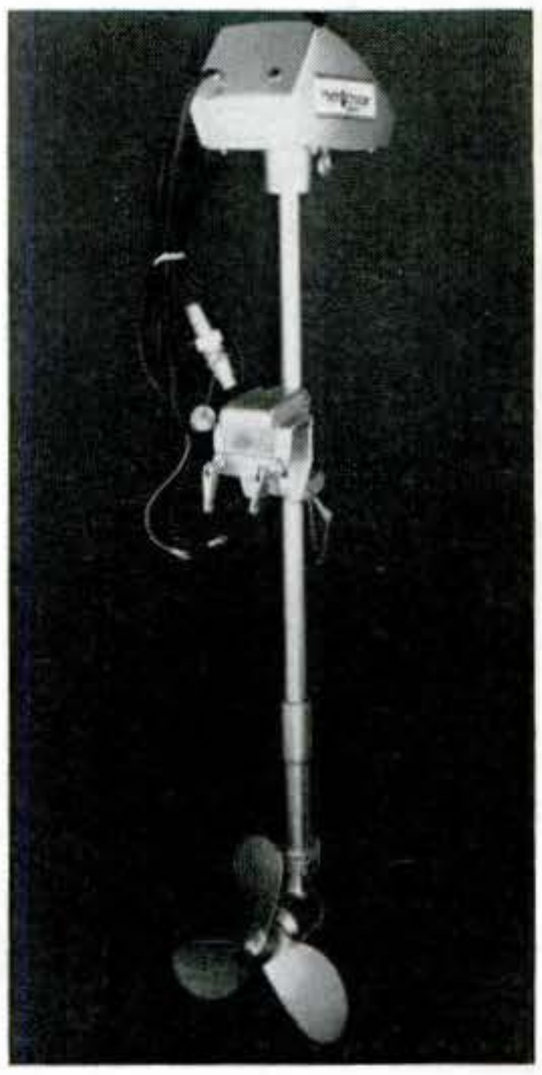
Floating trailer

Trailer your boat to the water, launch it, then launch the trailer! Its 10-ft. legs are for deeper water; 18-in. ones secure it to the bank. Result: a summer dock. The 20-by-5-ft. floating wheeled unit is $995 from Trailer-Dock, 33 Vista Dr., Little Rock, Ark. 72204.



Neat rails

Cluttered galley? Attach Raildex clamps to appliances, then clip 'em onto matching rails. To remove, flip open locking levers. An eight-in. rail section costs about $3; a clamp, about $8. Fairfield Consumer Products, 2777 Summer St., Stamford, Conn. 06905.



Collapsible kayak

Seven of these folding kayaks can fit atop a car, says its designer—the 10-ft. Naugahyde kayak has removable spreader boards. It's designed for both calm and white water, and costs $40 to build. Plans are $2 from Kayakraft, 417 Harding Ave., Livermore, Calif. 94550.

Electric charger

It looks like a small outboard, and mounts like one—but it's really a water-driven, 12-volt DC generator. The Hydrocharger 121 delivers up to 16 amps at 10 knots. It starts charging at under three knots, says Regent Marine, 1051 Clinton St., Buffalo, N.Y. 14206. $925.

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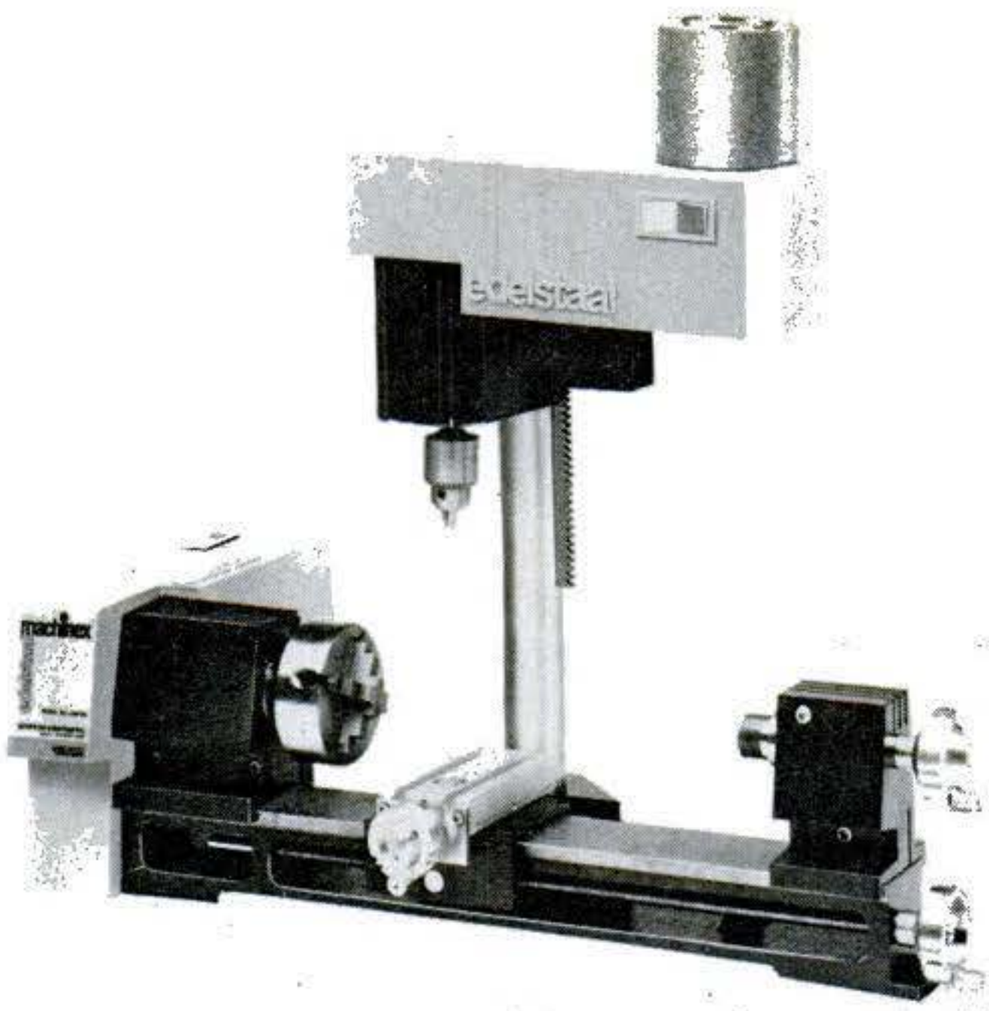
What's New IN TOOLS

BY R. L. STEPLER



Five-in-one lathe

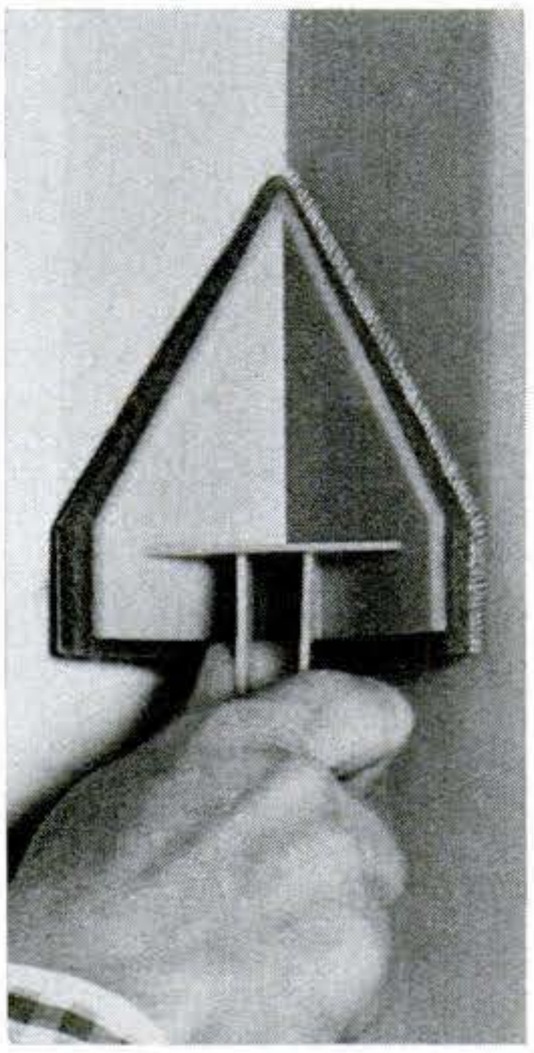
The Machinex 5" has five metalworking functions: lathe, drill press, vertical milling machine, grinder, and polisher. A ¼-hp motor delivers six spindle speeds from 250 to 4000 rpm. With 20" bed, it's $349; 24" bed, $379. American Edelstaal, 1 Atwood Ave., Tenafly, N.J. 07670.

Paint pourer

No spills or spatter if you insert a Pour Ring in a gallon paint can before pouring. The device also keeps paint out of the sealing lip, says the maker. A package of three costs $2.50 from Tracy Engineering, Box 688, Palisades, N.Y. 10964.

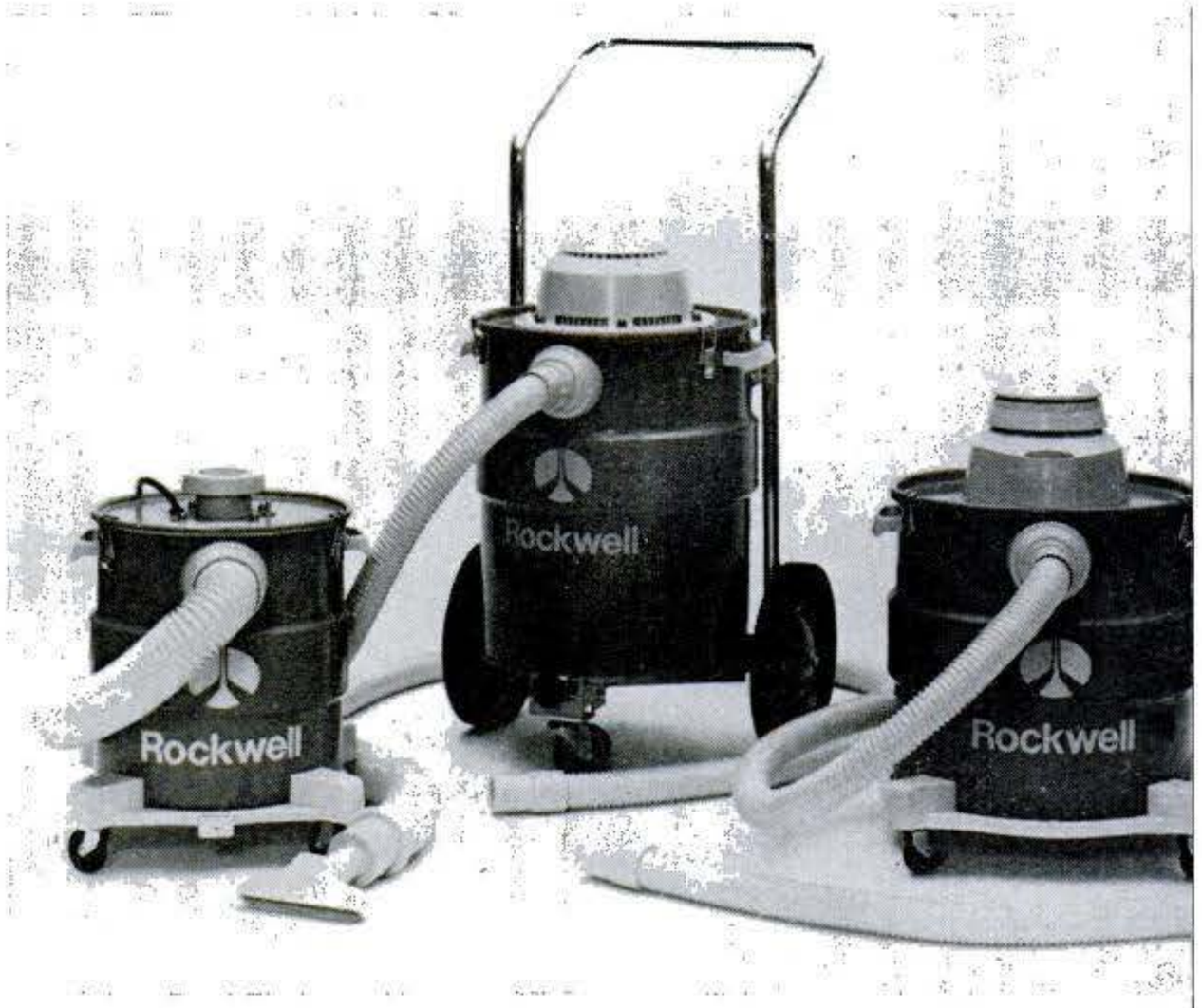
Plier plus

This long-nose plier also strips, cuts, and crimps wire, and cuts bolts. Dipped plastic-cushioned handles give the No. 908G Wire Tool a comfortable grip. The 8¼-in.-long tool is from Channellock, Meadville, Pa. 16335.



Corner coper

Paint yourself out of a corner with Padco's Corner Paint Pad. The tool lets you paint corners fast and gives professional results with its strong, easy-to-grip handle, says Padco (2220 Elm St., S.E., Minneapolis, Minn. 55414).

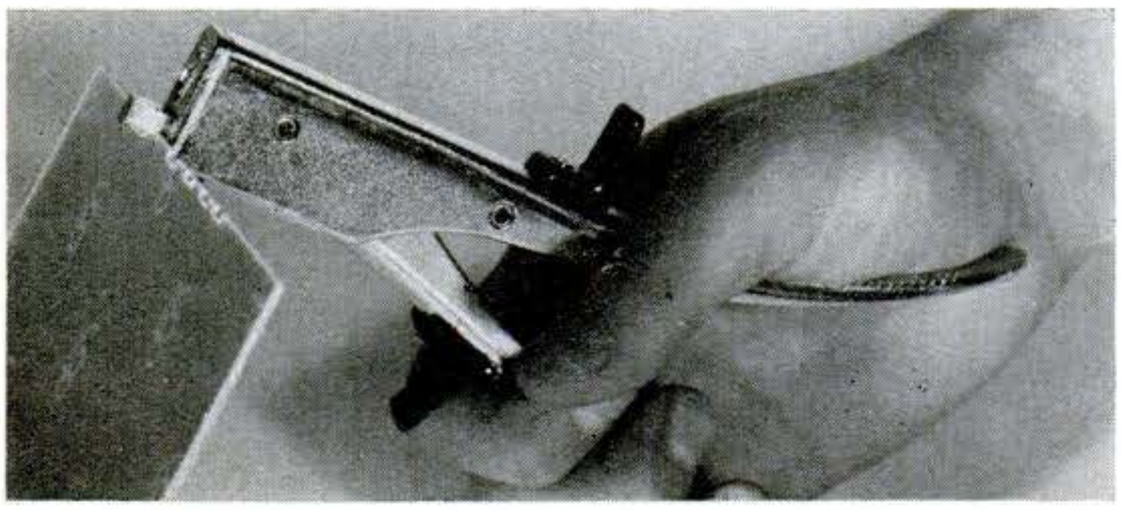


Shop vacs

Rockwell's new line of shop vacs includes the five-gal. model 1060 (left), at $70; the eight-gal. model 1064 (right), at $100; and the 10-gal. model 1066 (center) at $200. Rockwell, 6263 Poplar Ave., Memphis, Tenn. 38138.

Socket magnets

Hexagonal magnets ⅛" thick convert six- or 12-point wrench sockets to magnetic types. Magnaserts come in standard sizes from 7/16" to 1" and six to 24 mm. A 20-piece set is $6.73 from Stock Sales Co., Box 606, Mineola, N.Y. 11501.



Nibbler

The No. 805 nibbling tool cuts sheet metal like a chassis punch, according to its maker. The device nibbles up to 18-gauge steel or 1/16"-thick copper, aluminum, or plastic. GC Electronics, 400 S. Wyman, Rockford, Ill. 61101.

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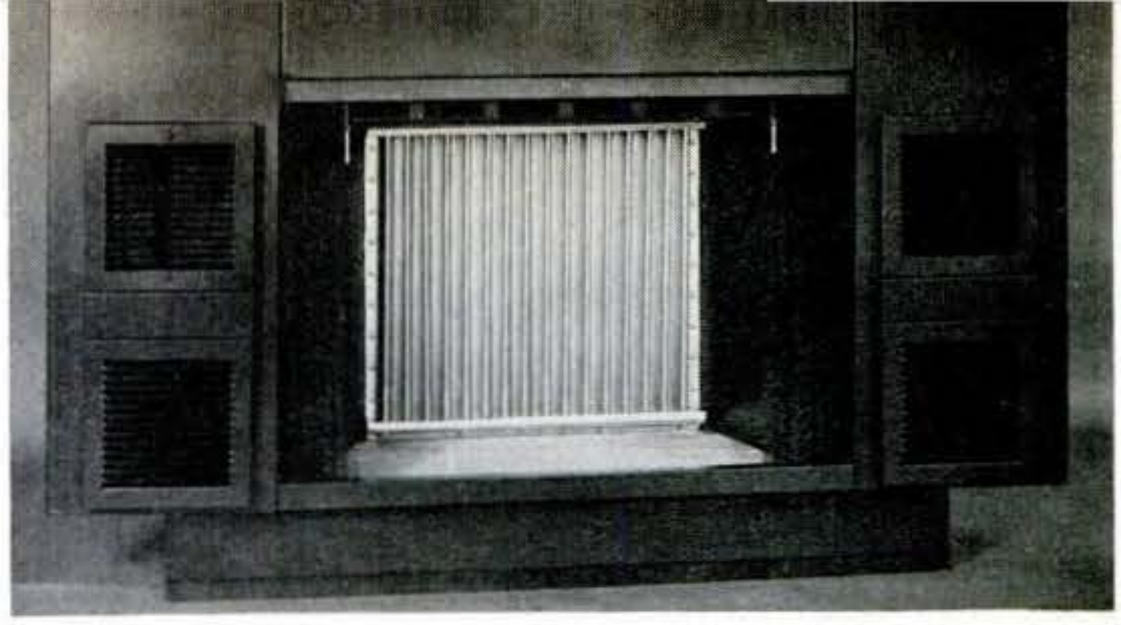
What's New IN HOME IMPROVEMENT

BY R. L. STEPLER

Fireplace I

A stainless-steel heat exchanger and side liners give increased radiant heat in this new zero-clearance energy-saving fireplace, says Majestic (245 Erie St., Huntington, Ind. 46750). Price of the prefab unit: $475.

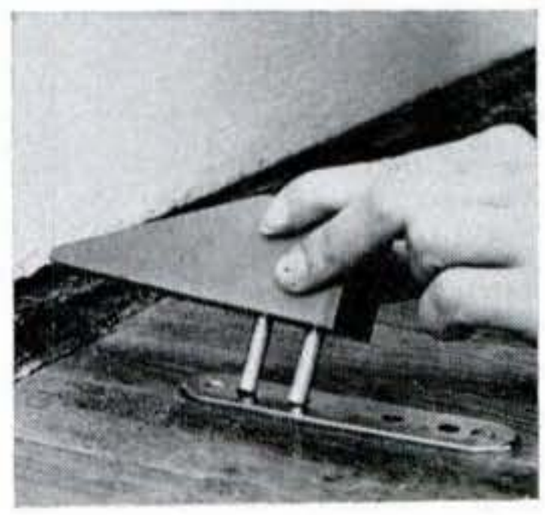


Fireplace II

Preway's Provider has a built-in fan for increased heat output. An Energy Mizer outside-air intake conserves energy, says Preway (Wisconsin Rapids, Wis. 54494). Price of Provider: $659 (black); $699 (red, green). Price of Energy Mizer: $43.50.

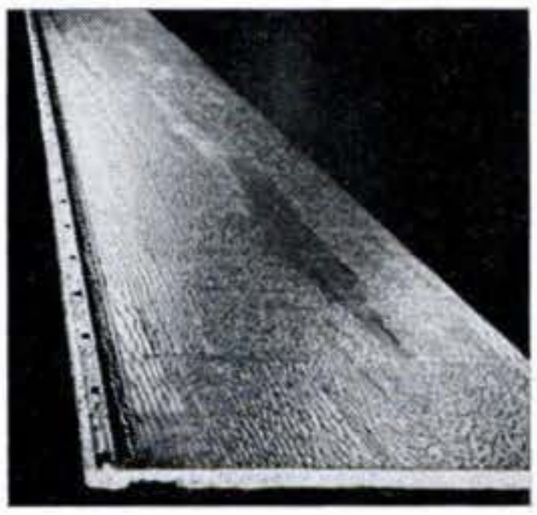
Grow light

Bright Stik Gro and Sho (below) produces a balance of red and blue light that promotes plant growth, says General Electric. Rated for 5000 hours, the 33-watt fluorescent fixture has 470-lumen output, costs $19.95.



Door wedge

Stop that thief with Stoplock, a four-in. wedge of hard rubber that mounts on the floor inside the door. Two one-in. prongs fit into a steel plate. Price: $9.95. Maker: St. Croix Corp., 9909 S. Shore Dr., Minneapolis, Minn. 55441.



Aluminum siding

Aluminum siding with polystyrene insulation and an aluminum breather foil can reduce heat loss through walls by up to 40 percent, says Reynolds Metals (Box 27003, Richmond, Va. 23261). It's available on Reynolds' American Classic and Vinyl-Tuf lines of siding.

A thermometer and solar controller

An electronic thermometer (top) provides remote sensing at up to 11 stations and up to 1000 feet from the unit. The model ET-O/350 reads from 0° to 350° F. Price, including three sensors: $74.50. Additional sensors: $4 each. The differential thermostat (bottom) is adjustable: A knob sets pump turn-on point (degrees by which collector temp may exceed storage temp) to compensate for season, water usage, etc., for solar water-heater systems. Price of DTT-70: $48. Both from Heliotrope General, 3733 Kenora Dr., Spring Valley, Calif. 92077.

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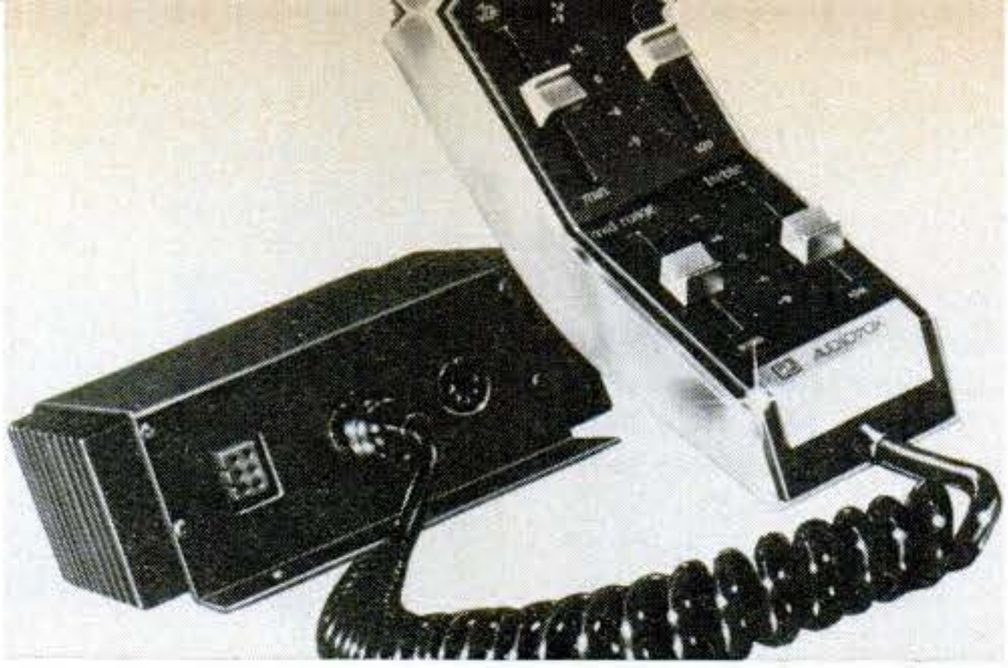
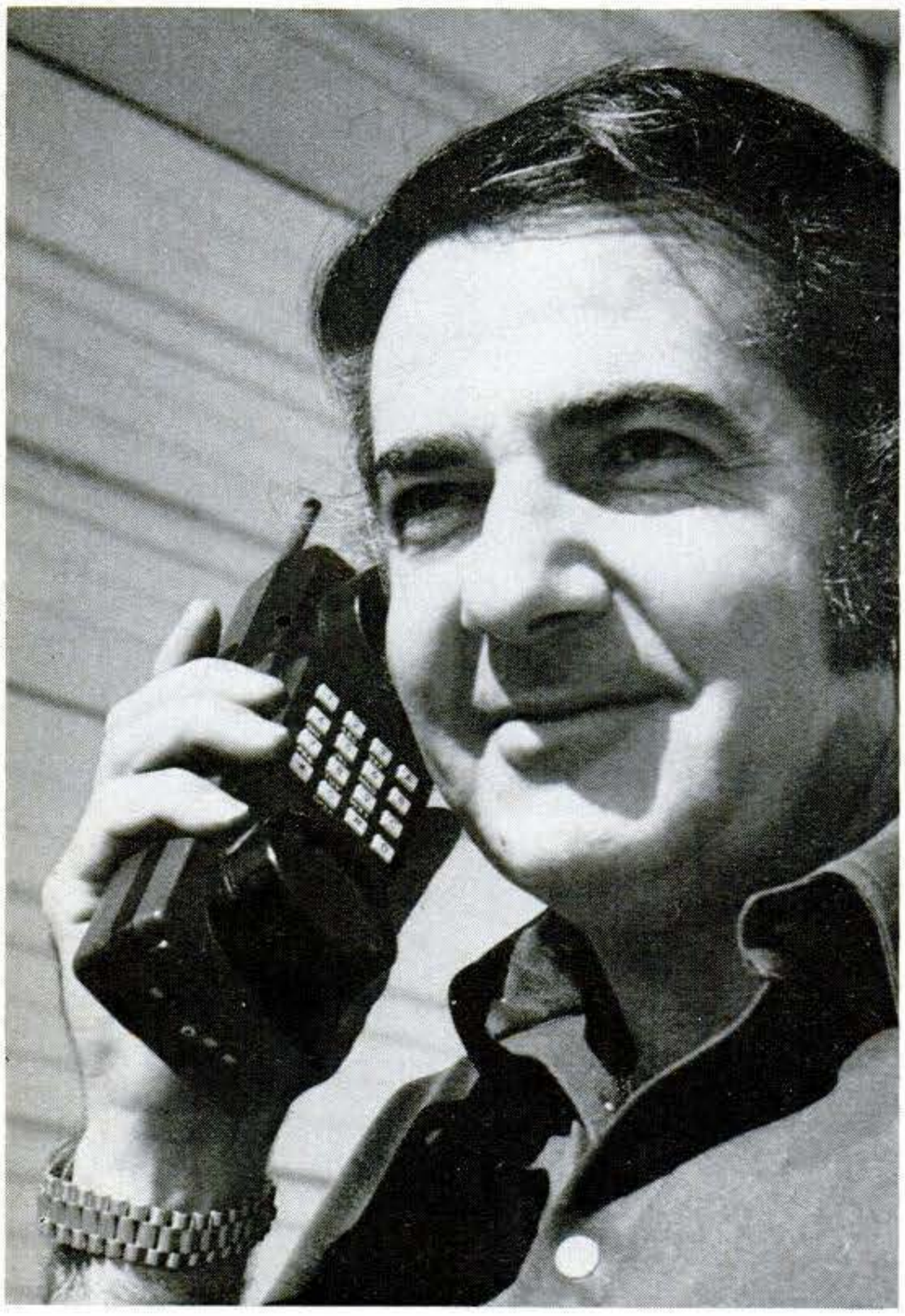
What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



Amp/equalizer

Add Audio Max to your car radio or tape system for up to 44 watts per channel of sound plus complete equalization control. The modular concept by Audiovox keeps black-box electronics under the seat and hand-held control box conveniently near. $99.95.

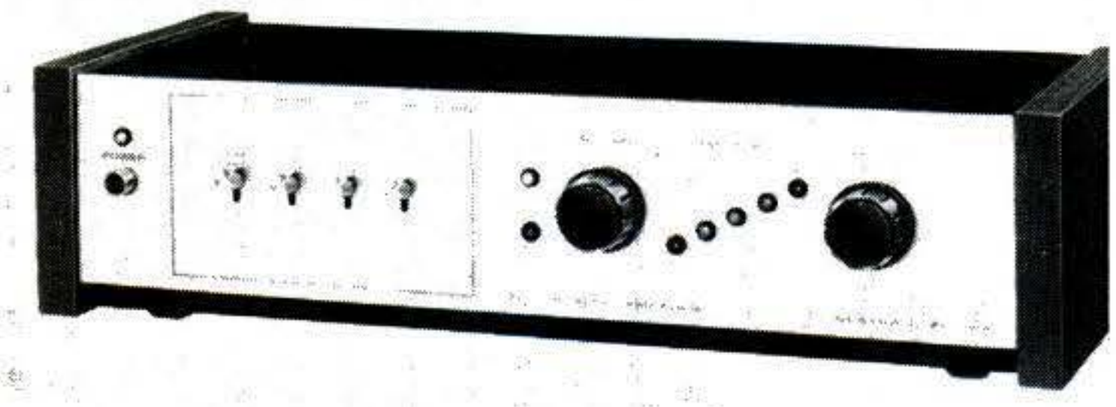


Channel checker

Push the transmit button on your mobile CB rig and this digital counter displays the exact frequency. It's small enough to fit anywhere, and no connection is needed to the rig itself. From Wawasee Electronics, Box 36, Syracuse, Ind. 46567, it's $99.95.

Portable phone goes with you

You're never alone with this handy box at your side—a portable telephone complete with dial-out and ringing capability. Made by Western Mobile Telephone Co., the unit weighs just 20 ounces and operates on 10 penlight cells. A push-button dialing pad calls out on any of five standard channels available, covering some 900 cities. The phone rings on incoming calls. The system is available at an $18 minimum monthly charge by the phone company. It's made by Western Mobile Telephone Co., 1924 S. Anaheim Blvd., Anaheim, Calif. 92805.



Audio processor

Connect this new audio processor to your stereo system and you've expanded the dynamic range and reduced noise at the same time. The AD-1304 processor is designed by Heath (Benton Harbor, Mich. 49022). It's built by you, however—it comes as a kit for $199.95.

Super base

Don't let all the buttons scare you—it's just a CB set. But it's not only a CB set—it's Superscope's CBB-1040 base rig, and it's got everything from a clock to a channel-9 scanner and tone alert. Power desk mike is included. $389.95.

Remote mini mike

You've probably seen wireless mikes that transmit to a nearby FM radio, but not one this small—2¼ by ¾ by ½ inches makes it a clip-on or hand-held unit for remote recording or PA applications up to 300 feet from receiver. It's $18.95 from AMC Sales, Box 928, Downey, Calif.

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What's New
FOR YOUR CAR

BY RICH CEPPOS

Tune-up kit

Tuning your engine? The Sun tune-up kit has all the essential equipment: dwell tach, timing light, compression and vacuum gauges, remote starter switch—and a manual. It's made by Sun Electric Corp., 3011 E. Route 176, Crystal Lake, Ill. 60014. Price: $170.

Add-on sunroof

Let the sun shine into your small- or medium-size car with this steel DIY Britax Sunliner sunroof. Rivet it into place in five hours; it doesn't weaken the car's structure, claims the maker. Price: $495. Glendi Corp., Third and Mill Sts., Bridgeport, Pa. 19405.

Coolant tester

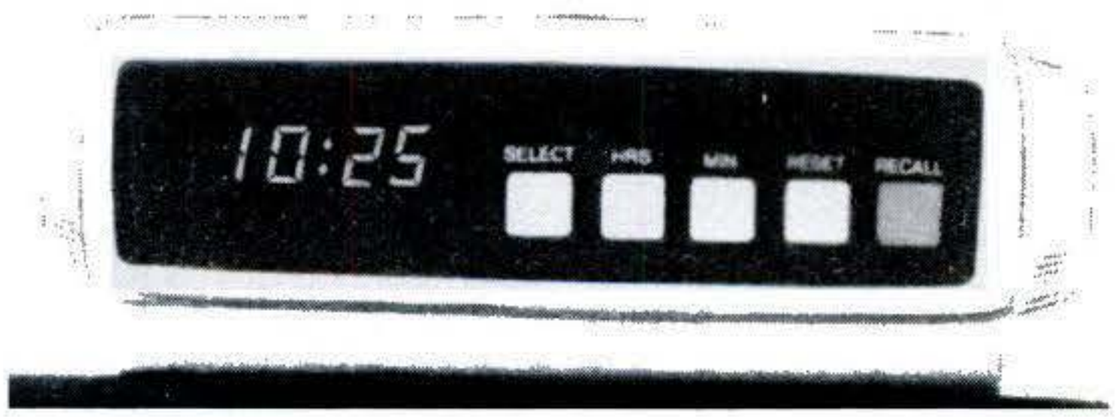
You can check engine coolant with this easy-to-use bulb-type tester. Six floating disks register protection level to as low as −40° F. It can be used on a hot or cold engine. Price: $9.84. Thexton Mfg. Co., Box 35008, 7685 Parklawn Ave., Minneapolis, Minn. 55435.

Breakerless ignition

Replace your standard points-and-condenser ignition system with the new Hays electronic breakerless unit and you'll improve performance, economy, plug life, and cold-weather starting, claims the maker. Kit includes a magnetic triggering system that replaces points and condenser, an adapter plate, power module, wiring harness with factory-installed terminals, and all necessary hardware. Installation takes less than an hour, doesn't require special tools or removal of distributor, says Hays Sales, 15116 Adams St., Midway City, Calif. 92655. Cost for most cars: $45.

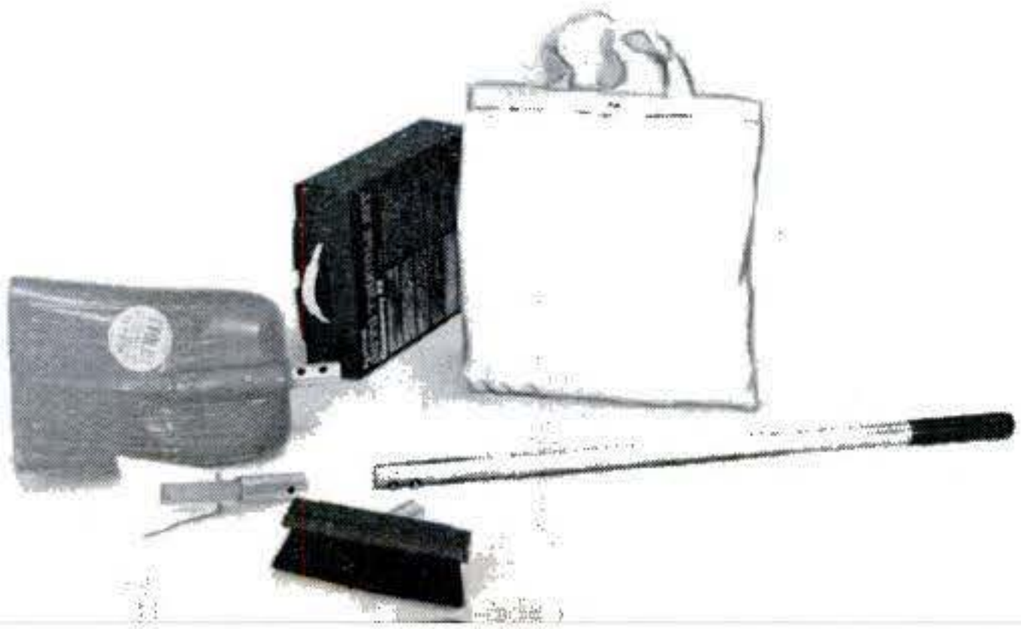
Double filter

The 15,000-mile dual oil filter from Purolator has about twice as much filtering material as most OEM filters and can absorb almost twice as much contaminant before clogging up, claims the maker. Dual media construction keeps it from splitting internally. It's about $4.



Dual digital

Check the time or clock races, trip duration, or sports events with the Indy/Cator digital clock. Time of day is displayed when the ignition is on; touch of the button starts the elapsed-time counter. It's $59.95. Sheller-Globe Corp., 2334 Production Dr., Indianapolis, Ind. 46241.



Snow-fighter kit

Dig out of snowstorms with the Blizzard Busters Kit: 42-in.-long snow shovel; 36-in.-long ice scraper; 34-in. snow broom. They fit in a 14-by-15-in. canvas tote bag, which you can slip into a corner of the trunk. Price: $17. Hycor, Inc., 1 Gill St., Woburn, Mass. 01801.

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Elliptic tire

stretches your gas mileage

The shape of tires for the '80's? High mpg and better handling might make it so

By HERBERT SHULDINER

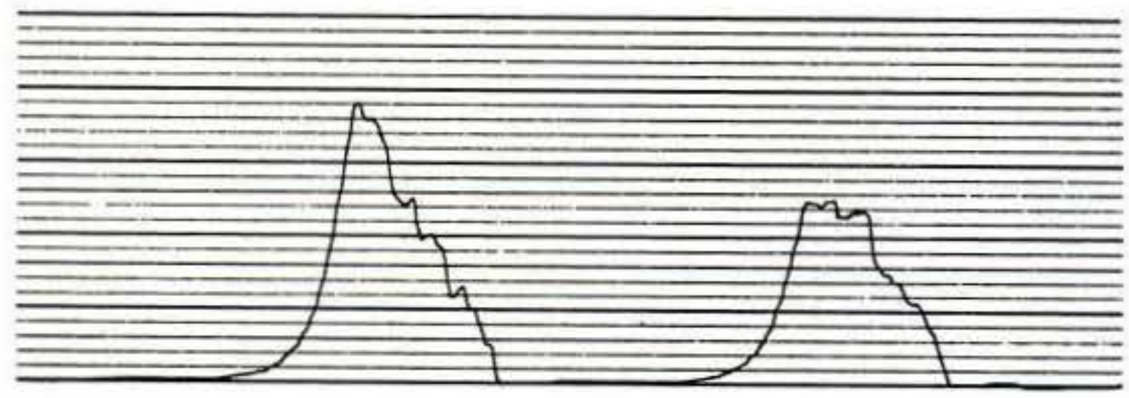
AKRON, OHIO

The three 1977 Plymouth Volares parked beside Goodyear's Dynamic Test Lab here in Akron were identical—except that one could go up to 25 miles more on a tank of gas. The reason was in the tires. One had a set of bias-belted tires, a second had four top-line standard radials, and the third, new elliptic radials that the world's biggest rubber manufacturer hints is the state-of-the-art tire for the '80's. What's more, the company claims the squatty-looking elliptic tire not only improves a car's mpg by a minimum of three to six percent—but also improves the handling in the bargain.

Walter E. DeVinney, manager of Goodyear's tire test division, invited me to drive the three cars to see for myself.

I drove each car on a somewhat makeshift track near the test lab—down a straightaway, around a loop with sharp curves, and back again several times. I anticipated the better handling of the standard radials over the bias-belted tires as I looped around the track. But I was surprised at the handling of the car with the elliptic tires compared to the one with standard radials. Steering seemed quicker with the elliptic tires, and I had more confidence going around corners at higher speeds than with the standard radials.

I didn't perform any fuel-economy tests, but PS Automotive Editor Jim Dunne observed such tests at the old Packard Proving Grounds track in Utica, Mich., in which the elliptic tires got 7½ percent more mpg than standard radials at 50 mph. Goodyear says that in some tests elliptic tires have increased gas mileage by as much as 10 percent. But on average the company claims an mpg improvement of three to six percent over radials, which get about three



Strip chart feeds out of special meter above as PS editor Herb Shuldiner drives test car over bumpy course to record ride comfort. Chart above shows that elliptic tire (at right) transmitted less vibration than standard radials.

Elliptic-tire-equipped car (front) went 13.8 percent farther than car with standard radials (middle) and 23.2 percent farther than car with bias-ply tires, after all three cars were shifted into neutral while going 25 mph.

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Unique elliptic tire is tested on flat-bed lab machine in order to measure its cornering ability and rolling resistance.

to six percent more mpg than bias-belted tires.

The mileage gets better as speed goes down from 50 mph, with the best saving at about 30 mph. The reason: The aerodynamic effect decreases under 50 mph and increases above that speed. So the commuter who does most of his motoring around town should reap the greatest benefit in gas bills. At speeds over 50 mph, savings are smaller, the company says.

What makes the elliptic tire get more mpg and produce better handling? "The key is its elliptic shape," says William M. Hopkins, chief engineer for radial passenger tires. "This allows the tire to be inflated to about 50 percent higher pressure than a standard radial."

The elliptic tire is inflated to 35 psi, compared to 24 psi for a radial. This helps cut rolling resistance as much as 34 percent compared to standard radials, the company claims. Pumping up inflation pressures has been a well-known way of cutting rolling resistance in tires for years. In fact, entrants in gas-economy runs in previous years sometimes ran with tires inflated to 100 psi, or more. That's okay for contests or stunts, but who wants the rough ride that goes with tires that won't cushion road bumps?

But with the new tire, what the higher pressure takes away, the elliptical shape gives back. "With the sidewall design of our elliptic tire and for other reasons we haven't been able to pin down," says Robert B. Knill, vice presi-

Continued

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dent of tire development, "the tire does not lose its good ride characteristics."

The elliptic tire looks much like other radials, except that the sidewall bulges more. It's a 65-aspect-ratio tire, compared to 78 for standard radials (aspect ratio is the tire profile, or shape, described as section height divided by section width). "When you go down from a 78-aspect-ratio tire, the footprint tends to get a little wider and a little shorter," says Knill. "The wider footprint inherent with a wider-aspect tire improves handling." (Note that Indy racing tires have a 35-aspect ratio.)

What gives the elliptic tire a rounder shape is the flatter flange on the special wheel it must be mated with (the elliptic tire cannot be used on existing wheels). The flange permits the carcass angle to approach the bead in a more natural fashion, Knill says. This shape gives the tire advantages in handling stresses, he claims. "We get a better absorption of road forces with the more curvilinear shape than with the standard radial's straighter shape," he says.

The sidewall of the elliptic tire thus becomes a sort of shock absorber when the rubber slaps road joints or jounces over potholes and railroad tracks. I became convinced of this when I drove a Volare with elliptic tires through the streets of this city, particularly searching for bumps and railroad crossings to test comfort. The Volare took the hardest bumps just as comfortably and smoothly as a car with standard radials.

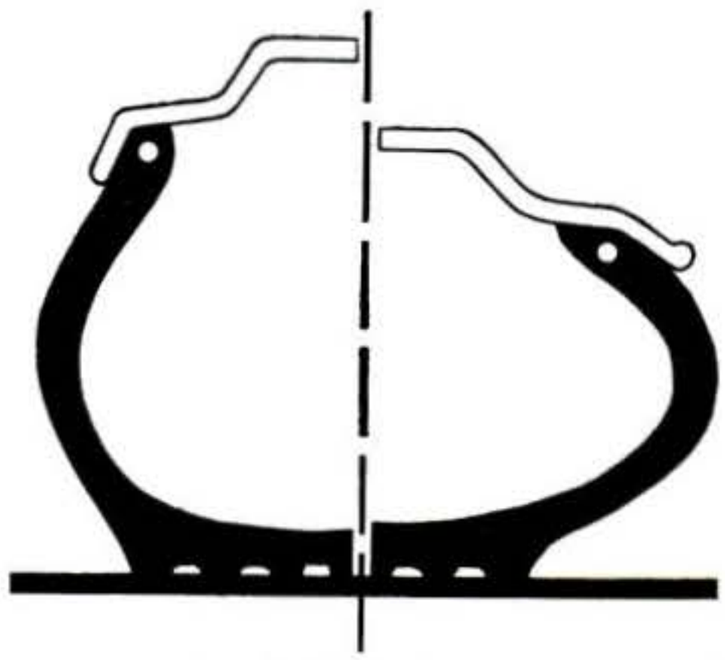
I had a chance to verify that subjective impression in a specially rigged 1977 Chevrolet Nova that Goodyear engineers had designed for checking comfort. One side of the car had standard radials and the other had elliptic radials. I drove the car about a half-dozen times over a series of rubber strips designed to make the car's tires bump. Each side was separately monitored by instruments, and a readout strip chart confirmed that the elliptic tires gave a smoother ride over the bumps.

Did Goodyear engineers give up anything in order to achieve better fuel economy and handling? The company claims the tire is just about a standoff with standard radials in almost every other respect —except traction. "That's the one area where we feel we're giving up some advantage," says DeVinney. "On dry pavement, the elliptic tire loses about one or two percent, and two to four percent on wet pavement," he admits.

"It's minor, in my opinion, compared to bias-ply and bias-belted tires."

Surprisingly, Goodyear says it has not yet tested the tire in snow. "But we have no reason to believe it won't be good in snow, and there's nothing that says it couldn't be made into a snow tire," Knill says.

The elliptic tire, however, has a very aggressive tread—almost as tough-looking as a snow tire. The 12/32-inch tread depth is distinguished by an absence of the circumferential grooves most tires have to direct water back and channel it away. The tread of the computer-designed elliptic tire is designed to minimize hydroplaning, says chief engineer Hopkins. It provides for free-flowing channels to carry water away. One bonus of the circumferential groove-free design is that it doesn't cause the trolley-track effect some tires do when you drive on grooved highways.



Elliptic tire (right) has more curved sidewall than standard radial (left). Note flatter flange that helps keep elliptic's shape. Curvier sidewall has more flex.

Goodyear won't reveal the exact chemical composition of the tread compound used in the elliptic tire. Knill says the compound has the same basic polymers as standard radials and a slightly different carbon-black ratio. (Carbon black is a toughening agent for tire treads.)

But there's apparently enough difference to make the elliptic tire tread slightly more resilient. This also helps reduce rolling resistance, Knill says. Tread wear is about the same as for a standard radial, he claims.

There are no brand-new materials elsewhere in the tire, either. The carcass reinforcing cord is polyester, which is used in virtually all passenger tires today because it doesn't develop a flat spot. And Goodyear could find no other fibers that significantly cut rolling resistance better than polyester, Knill says. The belts are made of steel "because there's a certain magic about steel in tires," Knill says. "But there's no reason why we can't make this tire with steel, aramid, or glass," he says.

The elliptic tire is somewhat lighter than a standard radial because it's a little shorter. But the bigger wheel needed for mounting the tire is a little heavier, so the total weight of the package is about the same as that of a standard tire and wheel.

The elliptic tire can improve gas mileage and handling today. In the future it may even change design characteristics of cars. For example, the elliptic tire's 15.3-inch-diameter wheel will give Detroit engineers more room—an extra 1⅓ inches of clearance that will allow them to put in larger-diameter brakes with a maximum of 14 percent greater braking area. This could be a significant safety factor, Goodyear claims.

When will you be able to buy an elliptic tire? A Goodyear spokesman told me, as this issue went to press, that they will be available on some 1979 cars. The probability is that they will be introduced in mid-model year in small numbers. Lead-time requirements would prevent their use in big numbers until the 1980 model year.

Until they appear as original equipment, you won't be able to buy them anywhere. The complexity of fitting elliptic tires to a special wheel makes them a difficult after-market item to introduce. At the same time, once you buy a car with wheels designed for the elliptic tire, you won't be able to use standard radials on the same rim.

Goodyear says it's willing to license other companies to make this tire, but so far there have been no acceptances. It's more likely that the other major rubber companies will be coming up with fuel-saving tire designs of their own. They're under the same pressure from Detroit that Goodyear is. The car companies are striving desperately to raise average mpg levels. They're under federal orders to bring them up to 27.5 mpg by 1985. Every possible engineering technique is being employed—and right now it looks as if the elliptic tire may be one of the more successful. PS

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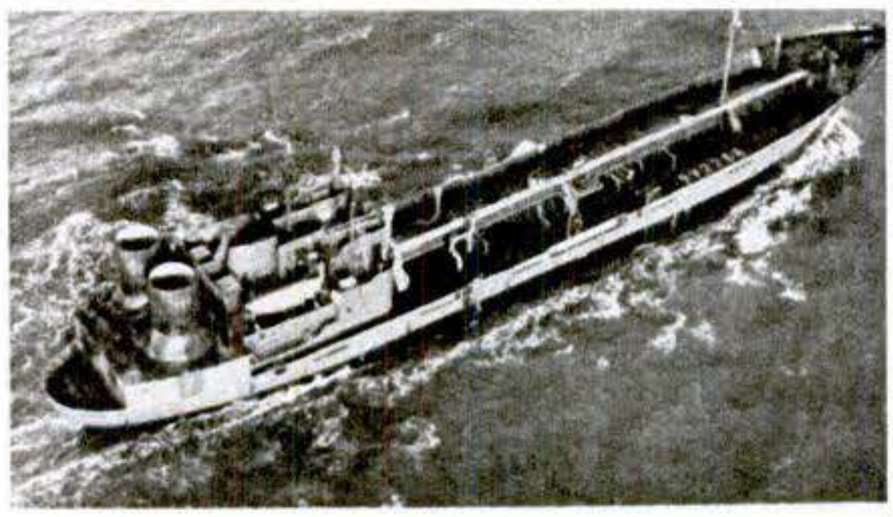
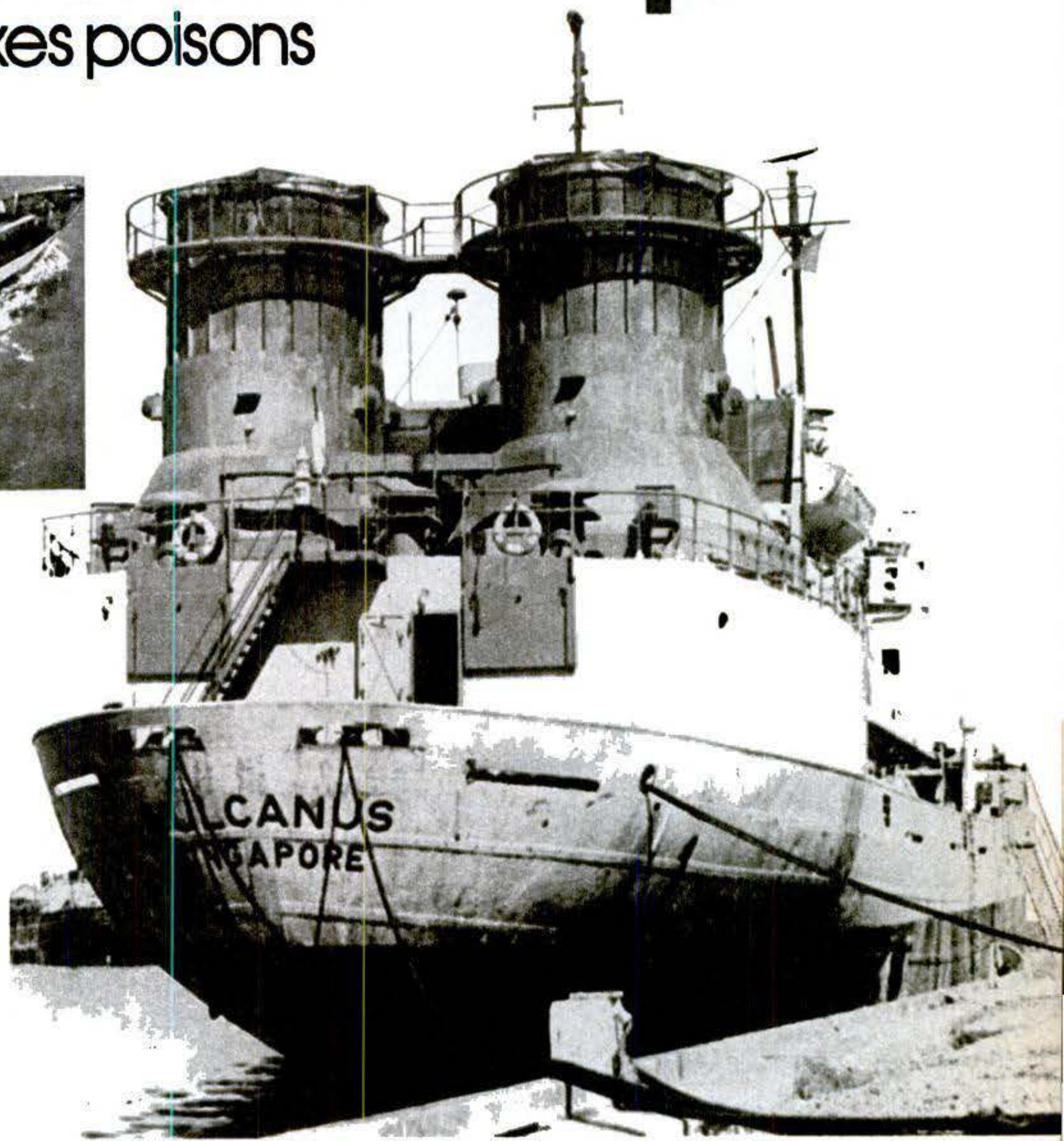
Incinerator ship
deep-sixes poisons





Twin stacks of Vulcanus emit wastes from six burners below. EPA requires combustion efficiency of no less than 99.9 percent, at no lower than 1250° C.

A converted cargo ship destroys a deadly chemical and proves a new method that's 99.9% efficient

By BRYAN BERRY

Last July, 120 miles west and downwind of Johnston Island in the Pacific Ocean, the cargo of a strange double-hulled ship began burning. It was no ordinary cargo: Called herbicide orange after the identifying stripes on the original storage drums, its use in Vietnam was halted when one of its components—dioxin—had been linked to an increased occurrence of birth defects there. Authorities had been wrangling for seven years over how it could be safely disposed of. The answer: incineration at sea. After the first burn, lasting two weeks, combustion was nearly complete: 99.99 percent, according to the EPA.

The incinerator ship, called Vulcanus after the Roman god of fire, had received high marks for combustion efficiency from EPA before—99.9 when it burned 16,800 metric tons of Shell's chlorinated hydrocarbon wastes in 1974-5. Since 1972, 50 to 60 miles off the North Sea coastline, the German-owned ship has been incinerating the chemical wastes of major European firms. Of the 10 million tons of nonradioactive toxic chemical waste generated annually by American industry, ships like the Vulcanus, some estimate, could safely destroy 5.4 million tons.

"Destroying the wastes *before* they reach the ocean is far preferable to direct dumping—or land-based methods such as deep-well injection," says Donald Carruth of the American Eagle Foundation, one strong proponent of at-sea incineration. "It's cheaper than land incineration, which requires scrubbing of emissions and operation of costly shore facilities." The hydrogen chloride (a combustion product) in Vulcanus's plume is dispersed over and neutralized by "the greatest buffering agent on the face of the earth—the ocean," says Russ Wyer of EPA's Division of Oil and Special Materials Control.

The ship's 15 cargo tanks hold 3503 cubic meters and are safely separated from the engine room by double bulkheads that enclose a pump room and generator room. At the rear of the ship are two combustion chambers, each housing three burners. Lined with silica firebrick, the burners have a rotating-cup fuel-injection system that provides vortex turbulence and distribution of the waste feed throughout the entire chamber.

The furnace is preheated with fuel oil to at least 1200° C. Large blowers supply up to 90,000 cubic meters of air per hour to each incinerator; total incineration capacity is 20-25 metric tons per hour.

The EPA, which hasn't yet issued final regulations on the method, "should actively encourage the building of incinerator ships," says Carruth. One source of ships could be the Maritime Administration, which offered in 1976 to sell small dry-cargo vessels from the National Defense Reserve Fleet for conversion to these new floating furnaces.

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Classical approach to luxury (above) features a tiled mural to put you in the Roman mood. Imperial blues and golds, arches, and wall sconces enhance the mood created by Wood-Mode cabinets. The contemporary path to luxury (right) begins with a mirrored ceiling, adds plants inside and out. Clean sculptured lines of American Standard's pedestal sink, toilet, and bath add to the look. Fixtures alone cost about $1050.

Bath designs
for elegant relaxation

Spacious—and expensive—luxury baths are the next step after luxury kitchens

By SUSAN RENNER-SMITH

Where do you relax? Flop down in the family room? Sneak off to the study? Or do you, like more and more people today, head for your plush new bathroom? Once the dullest room in the house, the bath is now often a spa, greenhouse, and luxury lounge.

"In the past few years, the trend toward luxury baths has accelerated," Loretta Marion of Sherle Wagner told me. I was visiting the company's showroom in New York to inspect the opulent displays of hand-carved marble tubs, hand-painted basins, and sculptured, gold-plated faucets in various designs.

An increasing interest in fine design for the home (and the money to pay for it) may be the major reason for the boom. For many homeowners, installing a fancy bathroom is the next step after redoing the kitchen. "There's a trend to luxury baths because people are upgrading their homes instead of moving to more expensive ones," comments Jerome Miller of Smolka Co., a New York plumbing supplier.

For other homeowners, status may be the reason for turning a bath into a luxury hideout. Still others may be inspired by fond memories of a honeymoon suite with mirrored ceilings and sunken tub—or perhaps by scenes from the late-late movie (Ginger Rogers sponging herself?).

And of course, today's bathroom offers new

Continued

Sumptuous retreat (above) has a five-by-seven-foot sunken tub. Sweeping curves accentuate the room's spaciousness, while separating toilet, bath, and vanity areas. Sophisticated jet-black fixtures from Kohler include separate sinks with handy shampoo sprays and gold-plated faucets. Kohler's price tag? About $3700. The simple yet elegant Oriental setting (right) has Japanese screens that create tranquil privacy. Kohler's 20-inch-deep Steeping Tub invites peaceful relaxation. You'll pay about $2420 for these fixtures.

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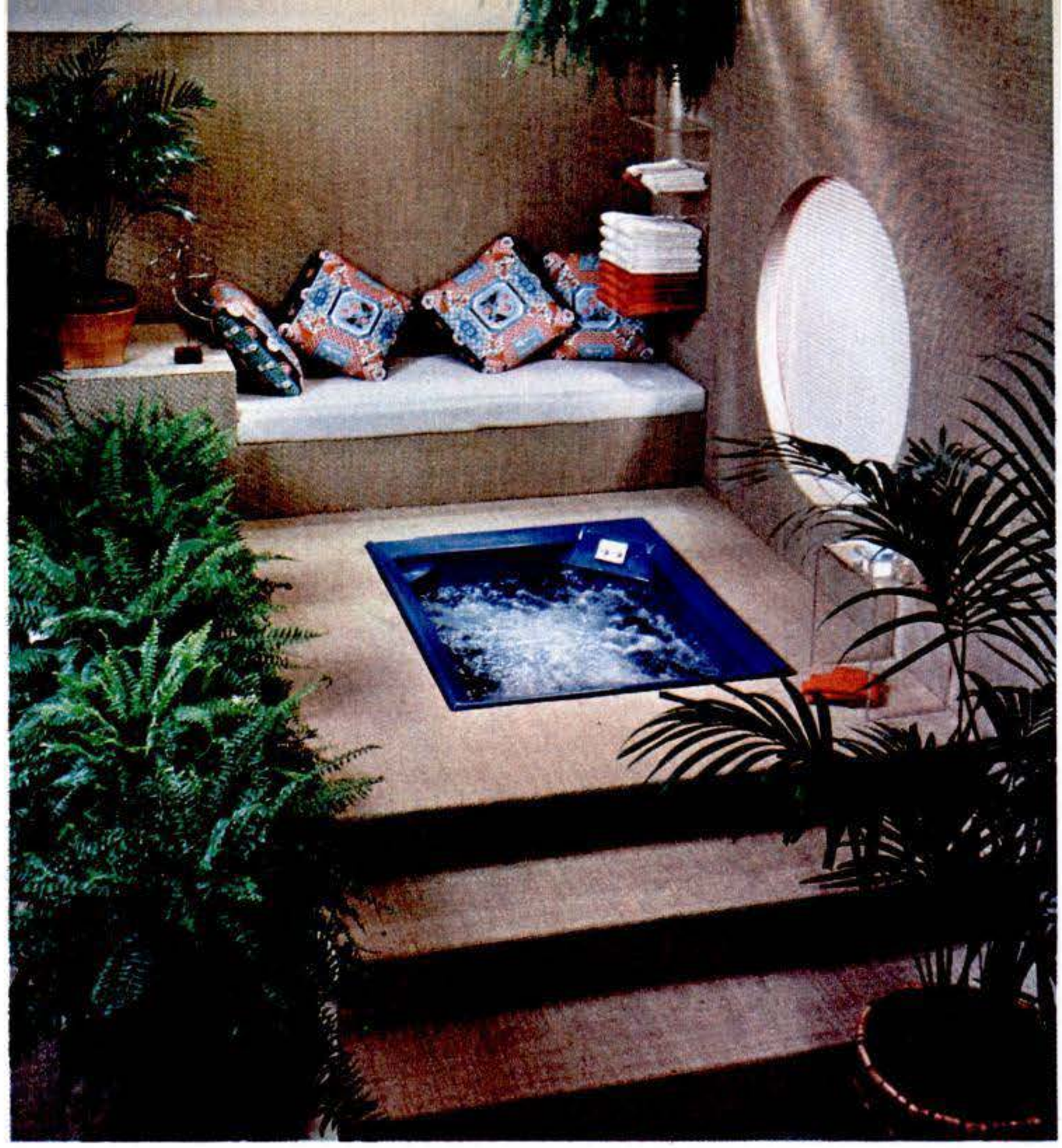
facilities. "People ask me why they should spend money at a health club when they could relax in their own whirlpool at home," said Micky Lewis of Baths International, a New York Jacuzzi dealer.

Whatever the reason, today's new bathrooms bear little resemblance to the plain ones most of us have. Fixtures once found only in millionaires' mansions—sculptured sinks, gold-plated faucets, bidets, sunken tubs—are becoming commonplace. Mirrored walls, plush carpets, padded couches, plants, skylights, even terraces enhance the decor. And the new bathrooms are spacious: Many have separate bathing, dressing, and toilet areas.

To illustrate these trends, we've assembled a collection of plush rooms by fine designers. You'll find some unusual ideas to play with. PS

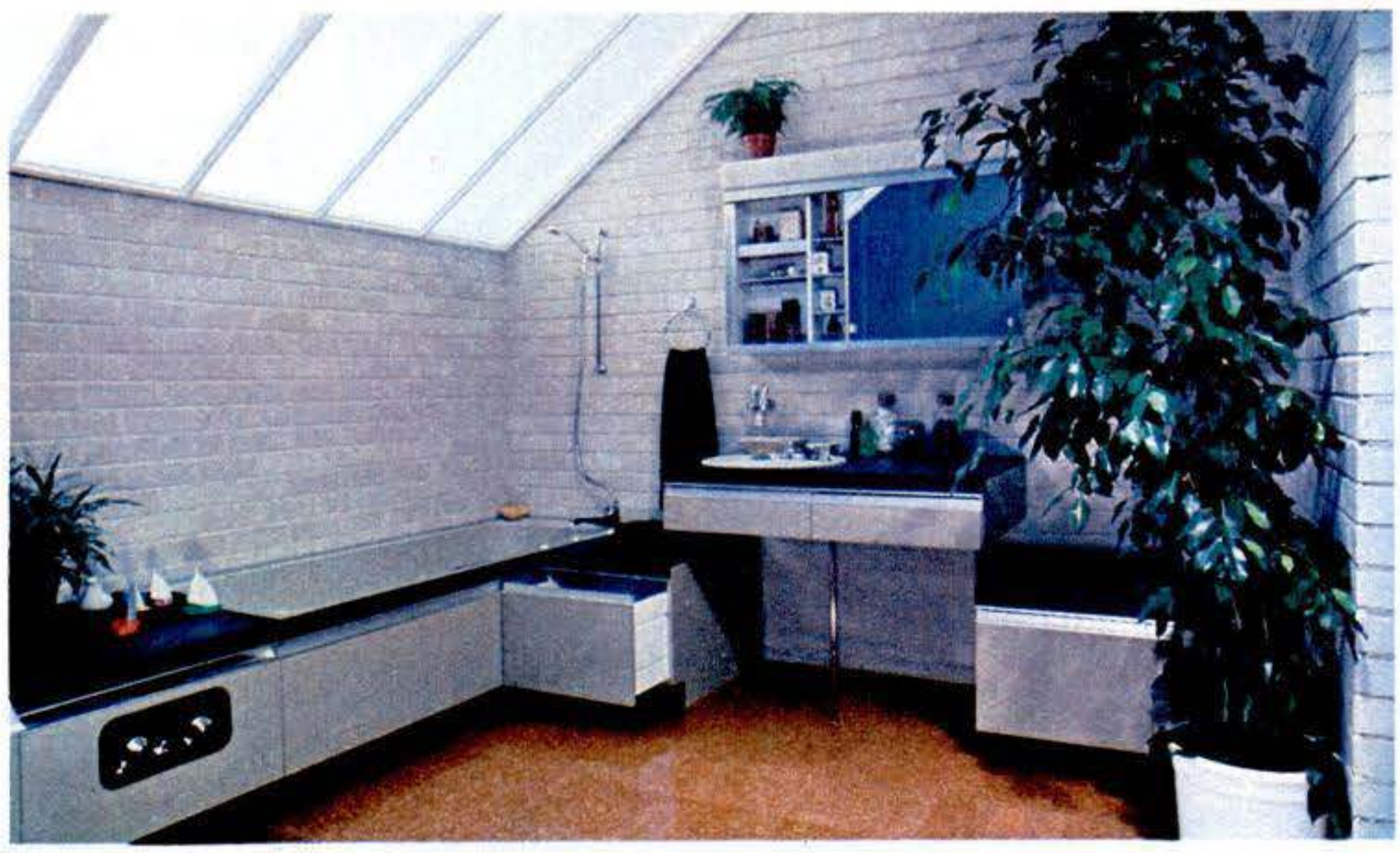
MANUFACTURERS' ADDRESSES

American Standard, Box 2003, New Brunswick NJ 08903; **Armitage-Shanks,** Armitage, Staffordshire, England; **Eljer Plumbingware,** 3 Gateway Center, Pittsburgh PA 15222; **Harrison Monobond,** Box 1, Ilkley, Yorks, England; **Hastings,** 964 Third Ave., New York NY 10022; **Jacuzzi,** Drawer J, Walnut Creek CA 94596; **Kohler Co.,** Kohler WI 53044; **Metlex,** Commercial Structures (distrib.), Box 701, Tomah WI 54660; **Pryde, Inc.,** 3517 Cardiff Ave., Cincinnati OH 45209; **Rusco American Bidet,** 100 Glendon Ave., Los Angeles CA 90024; **Saturn,** Allibert (distrib.) 315 E. 62 St., New York NY 10021; **Sherle Wagner,** 60 E. 57 St., New York NY 10022; **Wood-Mode,** Kreamer, Snyder County, PA 17833.



Class, Italian style (left), is shown in richly colored pedestal sink and circular tank toilet. Hand-painted tile and arched faucet are dramatic accents. Fluted china sink and toilet (below, left) have matching accessories. All from Hastings.

Bathe in a mountain pool, surrounded by light and greenery, massaged by gently swirling currents. The "pool" is Jacuzzi's four-by-five-foot tub (about $1765) with four-way whirlpool action and convenient corner controls.



They don't look like bathrooms, but these clean, uncluttered rooms (above and right) have all the necessities. The secret? Streamlined, modular units from Metlex. Bidet and toilet are camouflaged under square lids that form a continuous, bench-like surface (at left in photo above). Built-in tubs extend the smooth line. Modular drawers can go anywhere—in corners, between tub and toilet, or under two-sink vanity.

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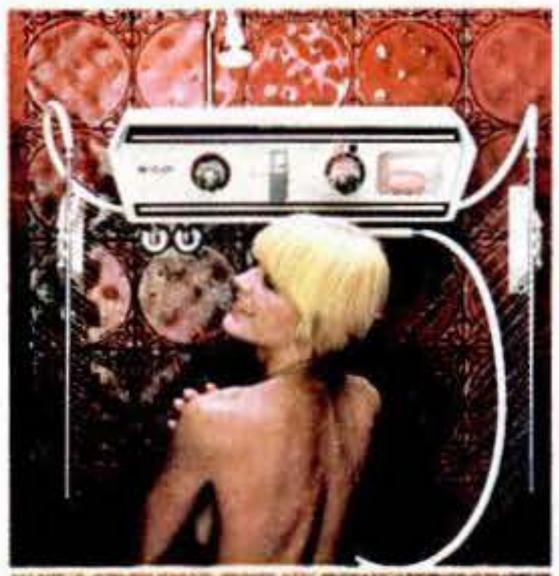
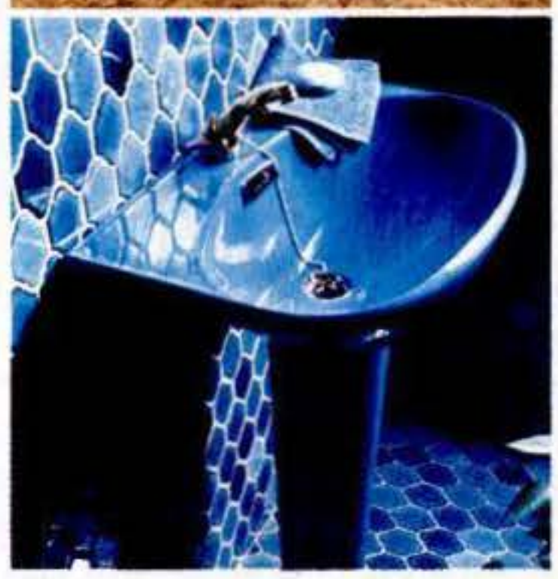
Lighting is key to the soft, natural look above. Translucent ceiling panels provide diffused light; globes around mirror give extra glow. Carpeted platform leads to Eljer's Delray tub with contoured corner seat. Stunning, super-size sink from Armitage-Shanks (below) is dramatized by arched mirror alcove. Window-seat arch echoes motif.





Four luxury items: Pryde's Electronic Impulse Shower (top right) spurts tingling jets of hot and cold water from all sides, and above; Rusco's retrofit seat (center) transforms toilet into handsome bidet; Harrison's sculptured sink (below) comes in range of rich colors; Sleek Saturn unit (far right) has built-in light, mirror, shelf, and basin.

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For cozy, fuel-saving winter 'survival', build a **warm room**

This superinsulated area can be a self-sufficient, snug family retreat during severe cold snaps

By EVAN POWELL

Only if you live in the tropics do you need to be reminded of the winter of '76-'77. Shortages of natural gas, predicted for several years, became a reality. Many Americans found themselves shivering in their homes at temperatures as low as 45 degrees due to voluntary thermostat setbacks or a lack of gas pressure.

We learned that natural gas, fuel oil, and electricity are, to an extent, interdependent. Natural-gas shortages caused business and factories to switch to fuel oil, which threatened *those* supplies; electricity demand reached a peak, causing widespread voltage drops and some power failures.

The warm-room concept

If you shivered in one of the areas hardest hit by the fuel shortage last winter, you may have longed for a warm, comfortable spot to retreat to. Why not build such a spot? Call it a "warm room"—a superinsulated, snug, self-sufficient area that's set aside for most of your family's living functions during severe cold snaps. The rest of the home would simply be maintained above freezing.

This may sound pretty grim, like a bomb shelter. But that's not the concept at all. A warm room should be an area that you personalize for your family's comfort, where all can relax and enjoy the things they like best. Indeed, you may find the warm room to be a favorite spot throughout the year, and that's the way it should be.

While preparing a warm room in our house, I learned much that can help you in establishing one of your own.

Locating the warm room

Your first step will be to decide where to put the warm room. You probably won't be able to find a space that meets all the following qualifications, but you can use them as a guide in selecting the best area available in your house:

Look for an area where there is already little heat loss. Search first along the southern exposure, since that should be the warmest side of the house. Try to select an area that has a maximum of one outside wall; avoid a corner room. It would be ideal to find a place at the core of the house with no walls exposed to weather, but this is unlikely in most homes. A basement area is an excellent location, since the ground itself provides insulation.

It's handy to have your warm room near the kitchen, which will normally stay substantially warmer than the rest of the house due to heat from cooking and heat vented from the refrigerator. It's also convenient to have a bathroom nearby. An area with a fireplace or access to a chimney gives you a natural spot for the heat source.

For energy efficiency, it's probably best to have no windows in the area, but you may want some for psychological reasons. And windows in a south, southeast, or southwest wall can trap some solar heat [PS, Feb. '75]. More about this later. Finally, keep safety in mind. There should be a convenient emergency exit.

The area you select will dictate many of the modifications you'll need to make. Use this rule of thumb: Prepare the area as if it were a free-standing structure. You are isolating it from the rest of the house, so the interior as well as the exterior walls should be insulated.

Hot air rises, so the ceiling is one of the most critical areas. If you have chosen a basement space, insulate between the rafters. Usually there is enough space between the floor joists to install at least six inches of fiberglass, or more than enough foam insulation. If your furnace or other heat source is oversized, you may want to allow some heat to escape into the house above to further reduce the load on the primary heating system. Don't omit insulation to accomplish this; use a register or grille to control the amount of heat loss.

Next, look at the walls. If your warm room is in the basement, you will probably build a partition to enclose at least one side. I suggest you frame with 2-by-6 studs on 24-inch centers rather than the more common 2-by-4's on 16-inch centers. This allows much more volume for insulation. If you are working with existing masonry walls, use foam planks or build a frame wall, insulate with glass fiber or foam, then finish with paneling or dry wall. If the area is below ground, you probably won't need additional insulation: it depends on your heat source.

Weatherstrip and seal the doorway into the warm room just as you would an exterior door (see photo). This probably means you will have to trim the bottom of the door and install a threshold on the floor.

Use double glazing or place heavy plastic over the interior of any win-

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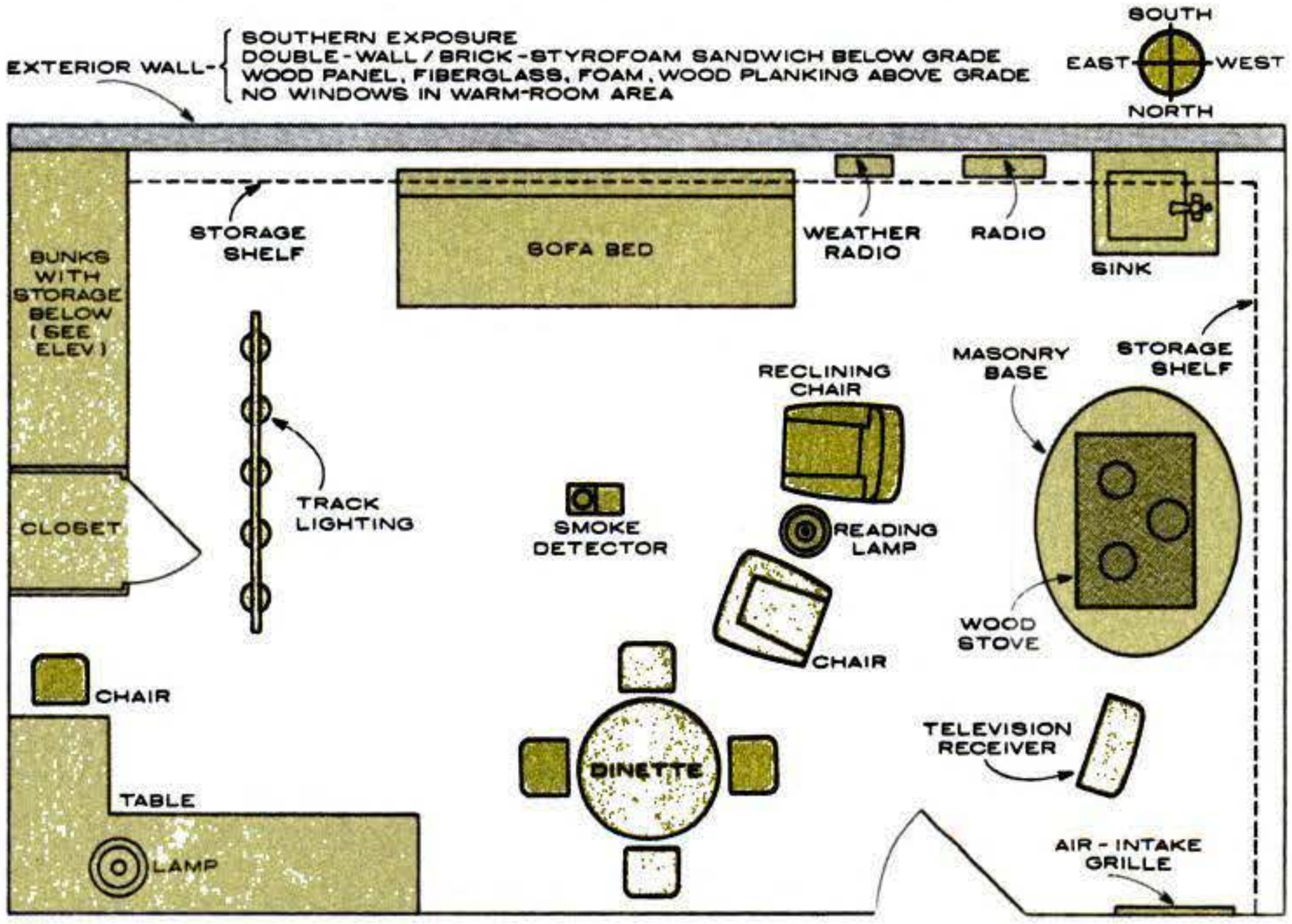
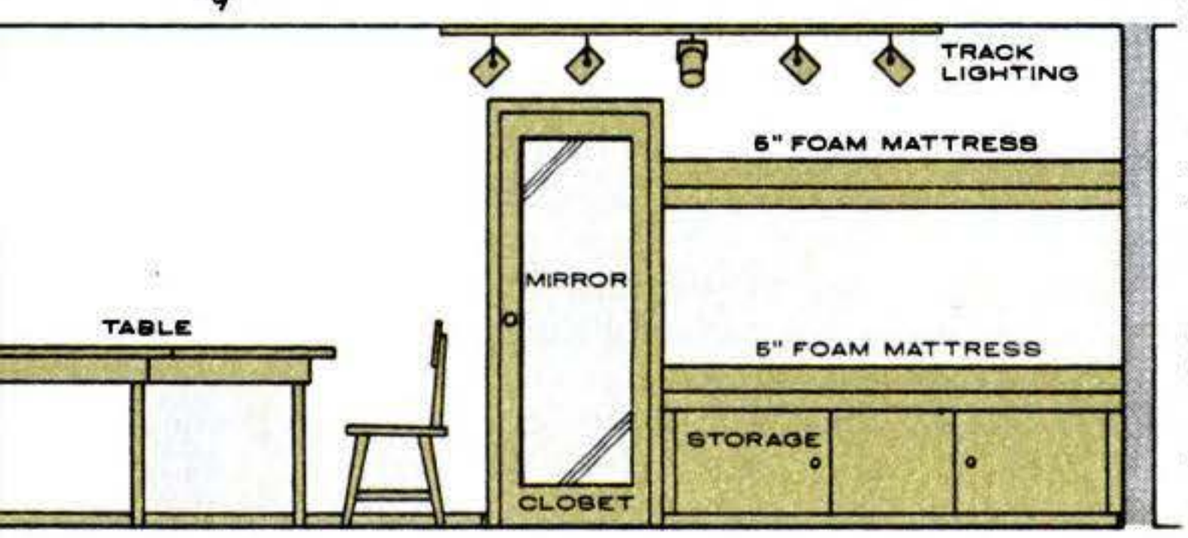
Independent heat source is most essential item in warm room. This is Tempwood wood stove. Fireplace, if made efficient, can also be used. Accessories and decor should be personalized to suit needs and tastes of the family.





Floor plan illustrates placement of furnishings. Battery-powered smoke detector is essential safety item. Adjustable air-intake grille provides combustion air for stove; it's located so that draft doesn't flow over areas where people are likely to be. Elevation (left) shows double bunks with storage (upper left on plan).

Insulate, caulk, and weatherstrip—everywhere. Here author is sealing and caulking joint between brick wall and storage shelf above. Interior walls are insulated with fiberglass, supplemented with foam panels on exterior walls.

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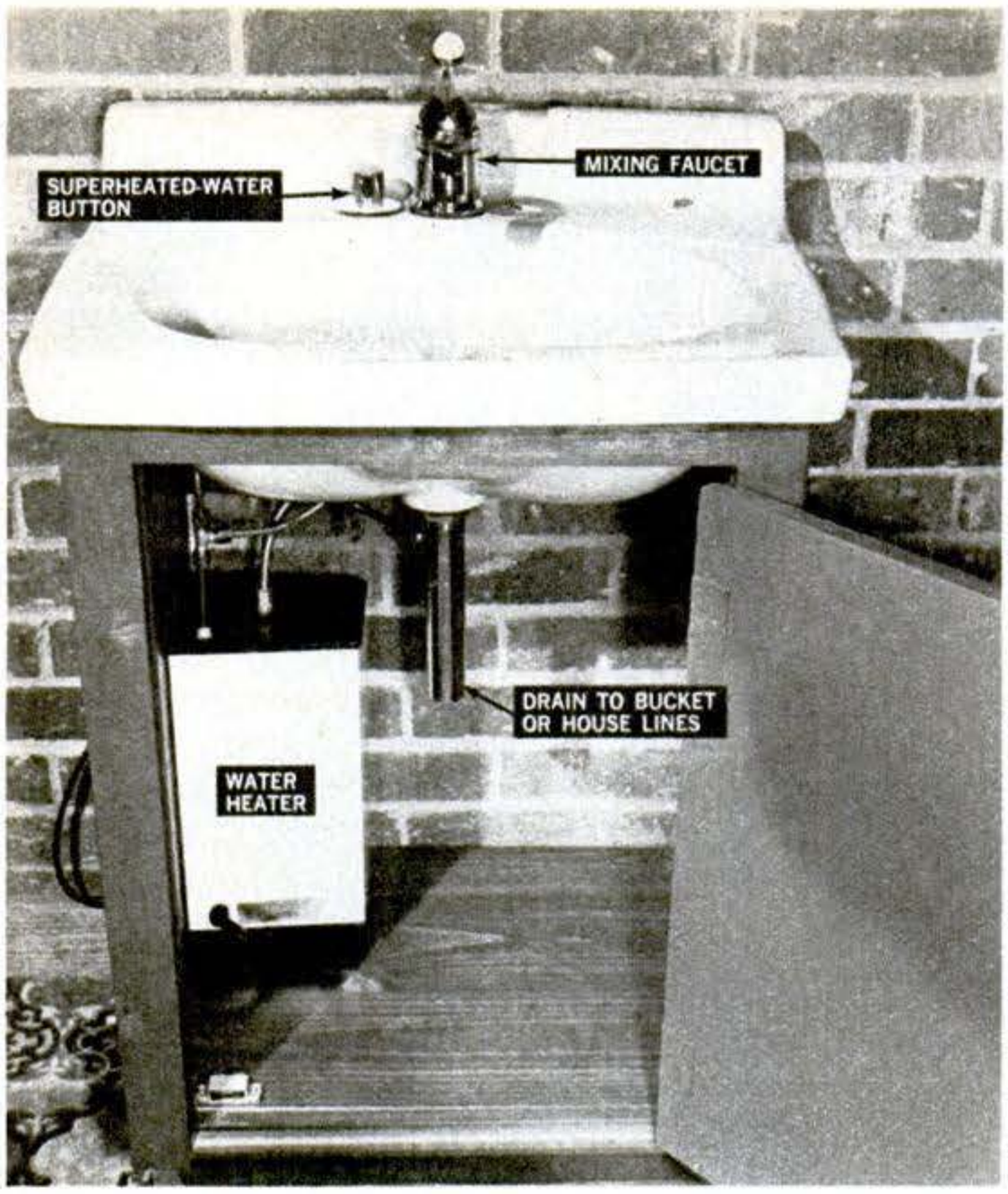
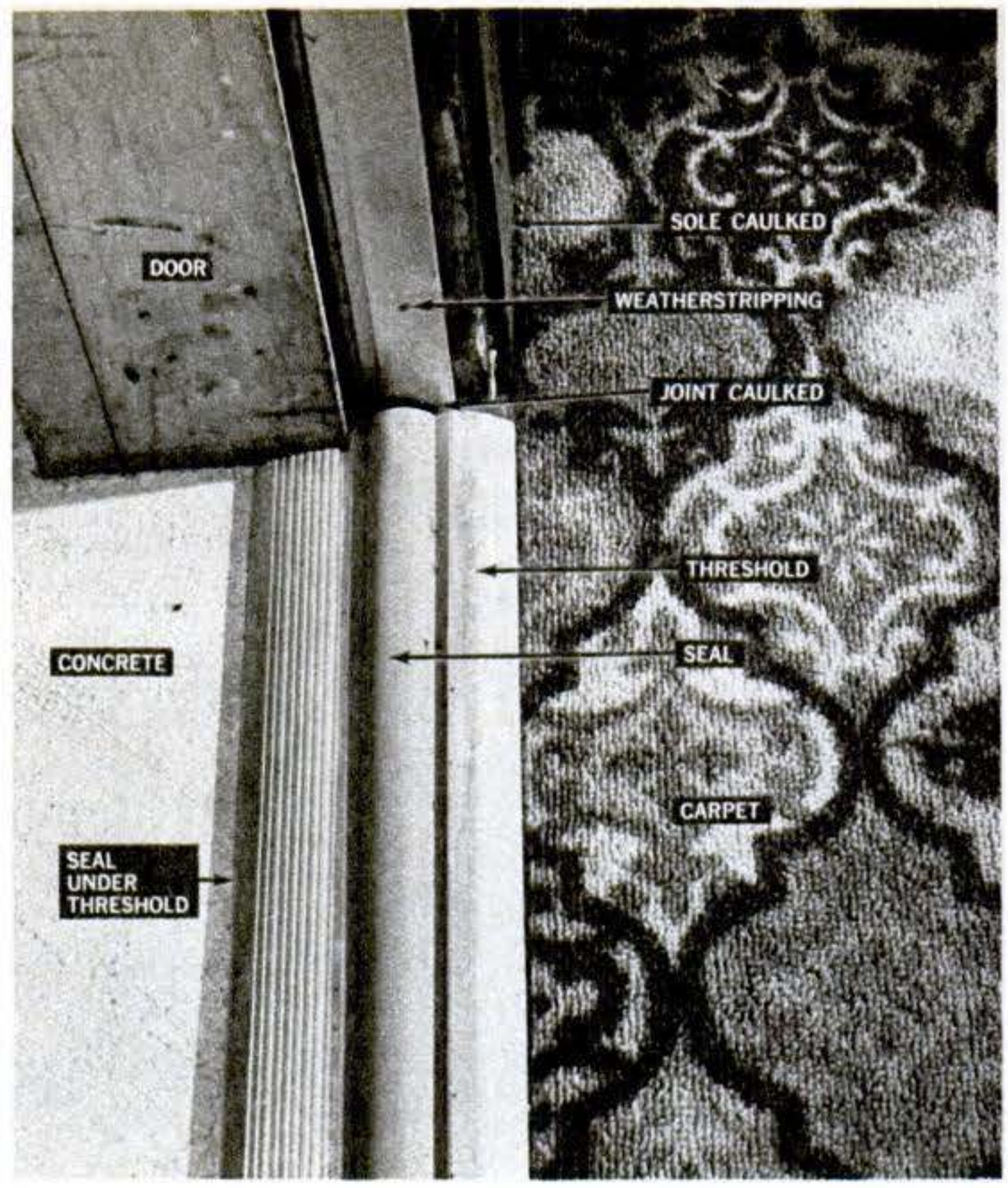


Point-of-use water heater in sink dispenses water at normal temperatures, or very hot water. Hookup requires only ¼" inlet line. If drain line isn't handy, use plastic tank under sink.



Entrance is weatherproofed as though it were an outside door. Threshold was installed, weatherstripping applied around door. Double-thick carpet pad adds insulation.

dows in the area. Capture solar heat by leaving blinds and curtains open when the sun is shining on the windows, but close them promptly at night and in cloudy weather. Heavily insulated draperies or shutters are recommended for all window areas.

Keep cold from reaching you through the floor area, also. If the floor of the warm room is located above a basement or crawl space, insulate between the joists. If it's on a slab in the basement, consider building a wooden platform over the slab, insulating between the studs, covering with plywood, then carpeting the top. All floor area should be heavily carpeted or covered with blankets.

Equipping for self-sufficiency

The primary piece of equipment required in the warm room is a space heater, but it should not be tied into your primary heating system, nor should it use the same energy source. Neither should it depend on electricity or natural gas. For all practical purposes, this boils down to one heat source: a wood stove or fireplace. In an emergency you can even burn rolled-up newspapers or wood scraps in these.

If you have chosen an area that has an existing fireplace, make it efficient. Installing a heat-trapping device is a good way to go. If you select one with a motor, choose a model that will operate from a 12-volt battery in case of power failure. [See "Energy-Saving Fireplace Accessories," this issue.]

For areas with no built-in fireplace, install a freestanding stove or fireplace. Stoves are generally more efficient, but a fireplace is cheerier to many people. We chose a Tempwood stove because it is compact, has high heat output, and also has a unique design that we wanted to test in use.

Installation of such heating equipment is critical; follow manufacturers' instructions and local codes to the letter. Allow plenty of clearance from wall areas, and provide a fireproof base or hearth [PS, Oct. '76, p. 107]. Several manufacturers now recommend using insulated smoke pipe to reduce cooling effects when a pre-engineered chimney is used with a wood stove. Chimney temperature is critical with wood fires, because creosote can build up if the chimney is too cool; a chimney fire can result if the creosote ignites. Be sure the chimney is installed correctly and is in good condition. Also, burn only well-seasoned, dry wood to avoid creosote buildup.

A wood fire needs a supply of combustion air. Provide this by placing a grille through a wall of the warm room into the cool part of the house. The grille allows you to control the combustion air and to shut it off altogether when the fire is out. Don't bring in combustion air from outside during severely cold weather. The reduction in flame and flue-gas temperatures can accelerate creosote buildup. Drawing combustion air from inside allows the house itself to serve as a tempering chamber to preheat the air. Open a window slightly in the cool part of the house to promote the air circulation.

Handy accessory

A small sink with an integral water heater is a convenient addition to your warm room. I installed In-Sink-Erator's new Ultra-Hot system, which has a single-lever faucet that mixes the water to the temperature you need for most purposes, and a special button for 180-degree water—great for instant hot beverages or soup. Using such a system may allow you to shut off your main water heater, since most of your hot water needs can be served from this point with no in-line waste.

A smoke detector is mandatory as far as I'm concerned: Install a battery-powered unit in the ceiling.

From here you can go to any extreme. Add reading lamps, a TV, stereo system, or whatever you desire, but keep the area functional and enjoyable. This can be a versatile room, used year-round. In fact, the addition of an air conditioner in the summer can let you sit out the worst heat waves without air-conditioning the entire house. PS

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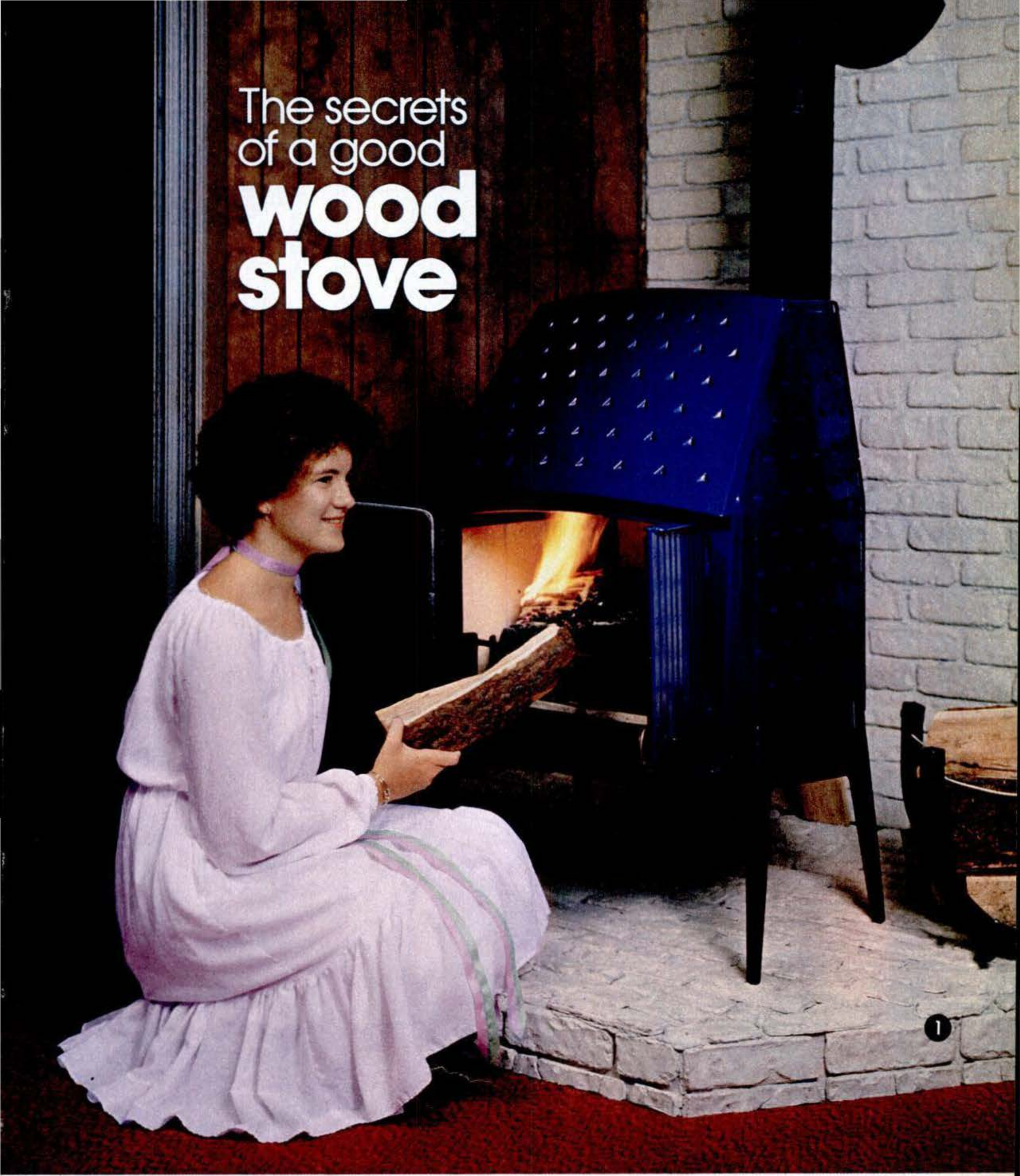
The secrets of a good **wood stove**



Does it have to be airtight? What about primary and secondary combustion? Manual or automatic controls? Here's how to sort out the features and the claims

By JASON SCHNEIDER

The winter of 1976-77: Newspapers headlined it, meteorologists said it was the coldest in a century, climatologists speculated that it heralded a new ice age, and newscasters orchestrated its furies. [See "Our Changing Weather," PS, Sept. and Oct.] But for millions of ordinary Americans the unrelenting freeze was more than simply a newsworthy nuisance—it offered convincing proof that their

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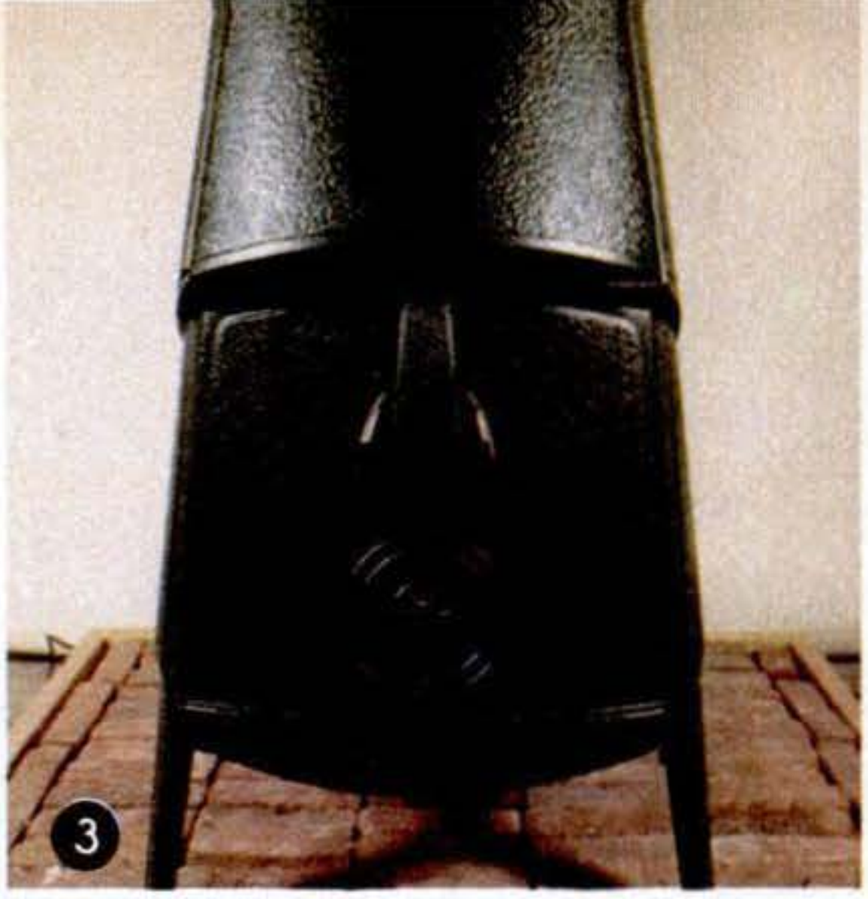
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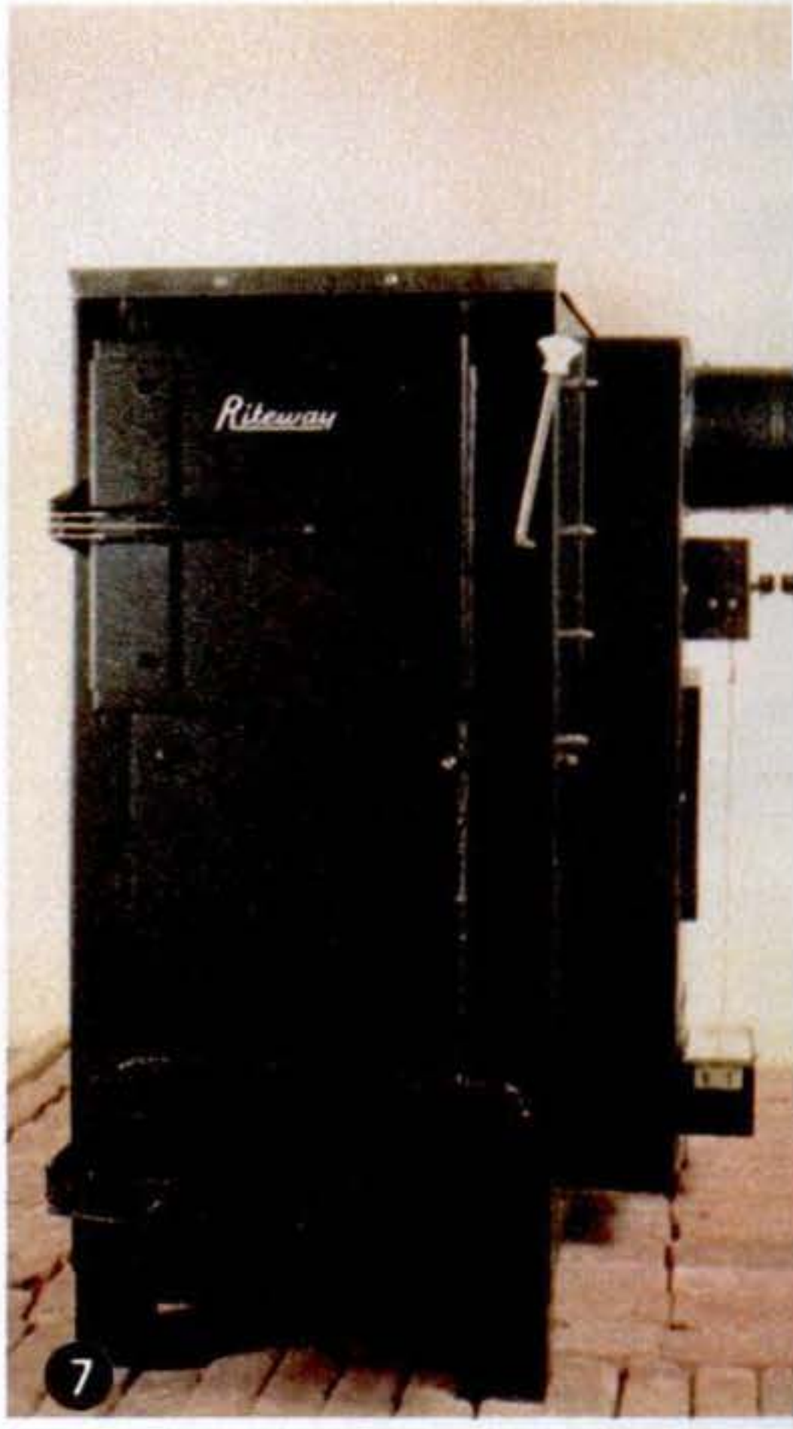

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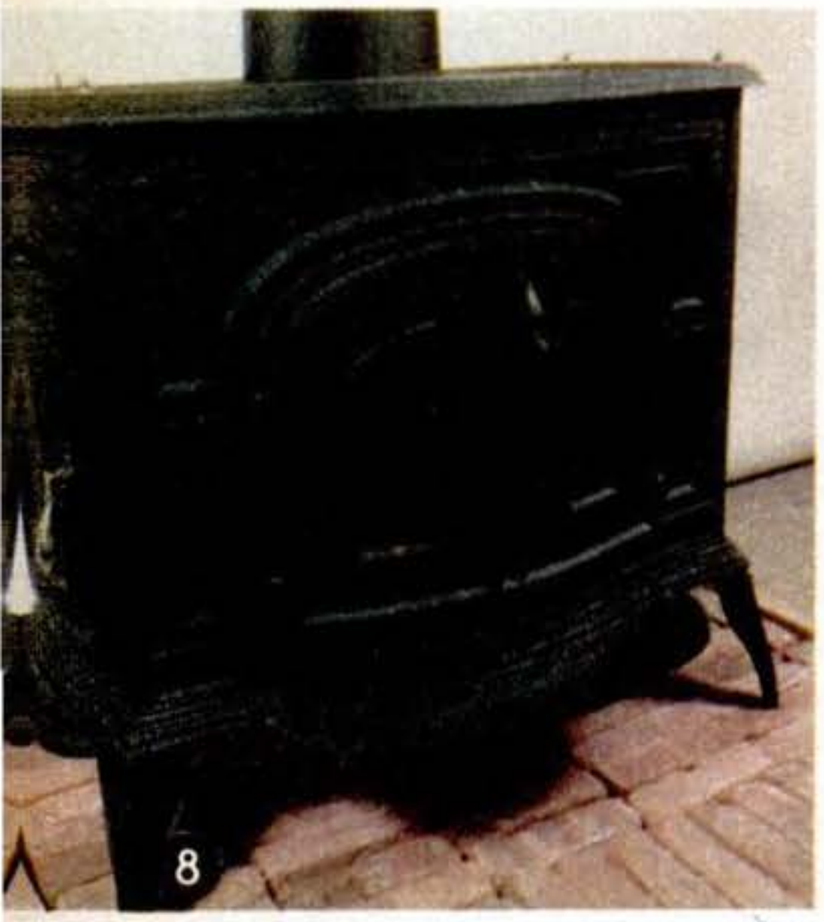
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1 Morsø 1125: Hinged doors of this fireplace/stove combination unit are asbestos-gasketed, move inward or outward slightly as you turn handle, permitting controlled amounts of air to enter above or below closed doors. When doors are sealed, air enters through hollow handle. Advantages: Standard 8" stovepipe connects to back or top; firebrick lining. Disadvantage: no ash lip.

2 Morsø 1BO: A traditional Danish box stove with arched heat exchanger, the 1BO has a precision-filed door-edge seal and single screw-type air-inlet control. A small twin-port preheating chamber is located inside the door. Advantages: firebox lined with cast-iron plates; drop-bolt door locks securely; relatively large ash lip. Disadvantage: relatively small loading door.

3 Jøtul 4: This stove/fireplace unit's asbestos-gasketed door hinges forward and stores under firebox. Door locks securely by means of vertical tapered bar that slides into a receptacle as you push hinged handle downward. Advantages: minimum floor space required; stovepipe connects to back or top; firebrick lining; Bakelite-covered handle stays cool. Disadvantage: no ash lip.

4 Jøtul 118: This classic Norwegian box stove has a removable asbestos-gasketed top plate to ease cleaning and a hinged asbestos-gasketed loading door. Advantages: accepts 25"-long logs; lined with removable cast-iron plates; stovepipe connects to back or to either side; Bakelite-covered door handle stays cool. Disadvantage: relatively small loading door (see table).

5 Lange 6302K: Loading door of this large Danish box stove has precision-filed door-edge seal and dual air-inlet controls with draft preheating chamber. Enclosed arched heat exchanger on top doubles as small oven. Advantages: accepts 25"-long logs; firebox lined with cast-iron plates. Disadvantages: stovepipe connects to back of heat exchanger only; relatively small loading door.

6 Norwester C-76: Thermostatically controlled American vertical barrel stove with horizontal smoke baffle. Stove is top loader with auxiliary manual draft control. Advantages: removable waffled cast-iron liners; vents from top or back via switchable flue collar; large loading door; coiled wire handle stays cool. Disadvantages: occasionally smokes when loading; ash removal difficult.

7 Riteway 37: Massive U.S.-made stove has shakable cast-iron grates suitable for wood or coal. Asbestos-gasketed loading and ash-removal doors. Thermostat controls primary air inlet, and preheated draft enters via two channels near bottom of firebox. Advantages: firebrick lining; removable ash pan; long burn time. Disadvantage: door handles require excessive force to close.

8 Defiant Parlor Stove: U.S.-made cast-iron airtight stove/fireplace combination unit has asbestos-gasketed front doors and side loading door. Thermostat-controlled air inlet directs preheated draft to small ports along back and sides of firebox bottom. Advantages: large loading door; removable cook plate; large ash lip. Disadvantage: Chrome handles get hot.

9 Ashley C-60: U.S.-made convection stove has sheet-metal inner firebox, asbestos-gasketed cast-iron loading and ash-removal doors, cast-iron grates. Thermostat controls primary and secondary air inlets. Draft is preheated. Advantages: cast-iron linings; twin air-inlet ports; accepts long logs; removable ash pan. Disadvantage: Automatic controls require precise stacking of wood.

10 Warm Morning 701: A convection stove, this U.S.-made unit has inner cast-iron firebox with asbestos-gasketed loading and ash-removal doors and nonshakable cast-iron grates. Thermostat controls air-inlet opening. Advantages: firebrick lining; two air-inlet ports at fuel level; removable ash pan; accepts long logs. Disadvantage: Effective fuel capacity is about two cu. ft. (firebox is 3.5).

home heating systems were either inadequate, or too expensive to operate, or both.

If you happen to be in any of these categories, you should consider beefing up your insulation; installing storm windows, doors, and weather stripping; and, in general, snugging up the old homestead. However, if that still leaves you cold (or broke), there's another traditional American response to winter's icy blast that's a remarkably effective and often surprisingly cheap source of heat —a wood-burning stove.

By now, most people are aware that a fully enclosed, reasonably airtight wood stove is far more efficient than an open fireplace. While the latter creates a homey atmosphere and warms its immediate vicinity when the fire's burning, it usually represents a net energy loss. Reason: The damper must be left partially open to exhaust residual smoke and gases even after the fire has mostly died down. Often this means overnight. Placing tempered-glass doors over a fireplace can cut this type of heat loss considerably, and there are several passive and blower-powered fireplace heat exchangers on the market that will boost its overall heat output. But a wood-burning stove is clearly the preferred appliance for heating with wood.

Which stove?

With dozens of different makes on the market (a sampling is pictured here), how can you make a rational selection? One logical criterion is power output, but because wood stoves, in general, don't produce heat as evenly as fossil-fueled central heating systems, most manufacturers and distributors don't rate their stoves' heating capacities in Btu, but rather in cubic feet of room space of "average construction" (see table). Once you've determined the amount of space you want to heat, you'll narrow your choices considerably.

Type is another consideration. Furnaces aside, wood stoves are divided into two major types: radiators and circulators. Radiators supply most of their output in the form of radiant energy, actually infrared rays in the region of about 900 to 40,000 nanometers. (The hotter you run a stove, the shorter the wavelengths emitted; the outer surface of a radiant unit will glow dull red—about 700 nm—if you succeed in firing it beyond its capacity.)

This radiant energy is not actually heat, but it becomes "sensible heat" as soon as it strikes something—walls or ceiling, your face, or even the air in the room. As you may have guessed, as soon as the air is heated, whether directly or indirectly, natural convection currents are set up between the warmer and cooler areas in the room, or throughout the entire house. That's why no stove is a "pure" radiator—some convection always takes place. However, by convention, any stove in which the visible outside surfaces of the unit comprise the outer walls of the firebox is classified as a radiating unit. Indeed, about 65 to 70 percent of the heat output from such stoves originates in the form of infrared radiation.

Circulating or convection stoves are most simply described as radiating units that have been encased in a louvered or perforated enclosure—usually of painted or enameled sheet metal. Their heat output is mostly in the form of hot air, which has been heated in the space between the inner firebox and the outer enclosure. Although the outer surfaces of circulating stoves don't get quite as hot as those of radiating units, they do get sufficiently warm to radiate significant amounts of infrared. So there is, likewise, no such thing as a "pure" convection stove—the term refers to its primary mode of heat transfer.

Both types are proven designs; neither is inherently more efficient. But radiant units can provide comfort at somewhat lower air temperatures (a plus factor for some),

Continued

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whereas circulating units probably have a slight edge in heating larger —particularly upstairs—areas. And though most circulating stoves have a distinctly boxy "heating-appliance" appearance, this "disadvantage" is offset by two positive features resulting from their lower outside-surface temperatures. You can safely place them closer to a combustible wall or furniture (24 in. as opposed to 36 in. for one of the larger radiating units). And you're less likely to burn yourself if you brush against the stove.

Airtight advantages

Actually, no wood stove I know of is truly airtight, but that's the term used to describe stoves in which virtually all the air (draft) enters the combustion zone (firebox) through air inlets or passages and not, for example, around edges of poorly fitting loading or ash-removal doors.

All the stoves pictured with this article are airtight or, as I prefer to call them, controlled-draft units, and their advantages are many. They can be made to burn longer and at lower power output if desired, and they ordinarily use 25 to 50 percent less wood than their non-airtight counterparts to generate the same heat.

The many non-airtights on the market include virtually all Franklin, potbelly, and traditional parlor stoves (both the American originals and their Taiwanese and Korean copies), and many cast-iron box stoves as well.

According to folklore, cast-iron stoves "hold heat" better, but this is a myth. The heat-holding ability of any stove is largely a function of its weight. Heavier stoves simply have a greater "thermal mass"—that is, they provide heat for a longer period after the fire has gone out (a useful property in home-heating applications). Of course, heavier stoves also take longer to provide useful heat from a cold start, so it's a trade-off.

Another trade-off is implicit in the great "cast-iron-versus-sheet-steel" controversy. Both materials have nearly identical heat-transfer characteristics, so there's little to choose between them on the basis of operating efficiency.

What it boils down to is this: Cast iron is extremely durable, but brittle. You can crack it with a sharp blow or by subjecting it to a sudden temperature differential. (Throw a heavy ice-covered log into a cast-iron stove and you might do both!) Furthermore, cast-iron stoves usually consist of a number of sections held together with screws and/or furnace cement. So, after you use a stove for about 10 years or so, you may have to re-cement some places where the original cement has chipped away.

Sheet-steel stoves ordinarily have welded seams, which are much less likely to require attention. But unlike cast-iron stoves, they can warp and bend with thermal stress. Since most of them start out rectilinear, you may find such bends unsightly. Operation is seldom affected, however. In any event, many steel stoves have cast-iron or reinforced loading doors to prevent loss of airtightness due to warpage.

Stove liners

Many stoves have fireboxes lined with metal plates, or mortared (or unmortared) firebrick. Such liners serve two main purposes: They protect the body of the stove from warping (in the case of sheet metal) and the enamel finish from cracking; and they help to maintain high combustion temperatures in the firebox, thus promoting more complete combustion. As added benefits, liners increase the thermal mass of the stove, which tends to even out temperature fluctuations during each firing run and helps to maintain tolerable room temperatures for longer periods after the fire has gone out.

All these reasons make it seem as though stove liners are an indispensable part of any good wood stove, but like most other generalizations applied to these highly idiosyncratic appliances, this turns out not to be true. The Defiant is but one of many successful wood-stove designs lacking internal liners of any kind. Like most good linerless stoves, its general massiveness and high-quality curved castings provide excellent heat retention and durability. Reinforcing ribs cast into its bottom plate add strength and extra heat-dissipating surface in this vital area. In short, although liners can and do perform beneficial functions in many stoves, they are not required in others. In my judgment, only thin-walled, rectilinear, sheet-metal stoves seem to suffer from the absence of liners, and even with these, the problem is mostly cosmetic—that is, warped sides.

Secondary combustion

Many advertisements and articles about wood stoves make a big deal about so-called secondary combustion of volatile gases. The underlying theory is, however, to a great extent questionable. Studies have proven conclusively that as wood is heated to combustion temperature, it does give off combustible gases such as methane, hydrogen, and carbon monoxide. If the fire is hot enough, say 1000° to 1200° F, a fairly large proportion of these energy-laden combustibles is burned in its immediate vicinity. As a matter of fact, the bright orangey or less-intense blue flames you often see when you observe the fire are produced by burning gases. But this is *primary* combustion because it occurs where the wood is.

Undoubtedly, not all of the flammable wood gases are consumed in primary combustion, particularly if the air-inlet (draft) control is turned down and the fire is smoldering. So the unburned gases go up the chimney and their potential energy is wasted. In consequence, many modern wood-burning stoves (good ones, bad ones, and in-between ones) have what's known as a secondary air inlet to permit sufficient oxygen (from the air) to reach these unburned gases and (one hopes) burn them, releasing their potential energy to the room being heated. This sounds commendably efficient, but there are problems.

First, combustible gases won't automatically burn just because sufficient oxygen is present; the temperature has got to be high enough for ignition to take place. Second, merely because secondary combustion may take place at one period of the burning cycle (for example, 30 to 50 minutes after you put a couple of fresh logs on the fire) doesn't mean that it will occur later (say, five hours later, after most of the wood has turned to charcoal). To top it off, the superior heat transfer obtained in a slow, smoldering fire may well offset the greater combustion efficiency obtained in a hot fire of shorter duration, in which most of the wood gases are burned. At least

Wood-stove safety tips

- Place stove on a noncombustible hearth at least ⅜ inch thick. Suitable materials include mortared brick or stone or asbestos board. You should provide a 36-inch clearance between the stove and a combustible wall, and 18 inches between such a wall and any stovepipe connections. Ideally, the hearth should extend at least 12 inches beyond all sides of the stove and 18 inches in front of the loading door. For additional information, write to the National Fire Protection Association, 470 Atlantic Ave., Boston, Mass. 02210.
- It's important to consult local fire regulations before installing any unit.
- Inspect a new chimney/stovepipe installation after the first few weeks to determine the rate of creosote formation and/or any malfunctions. The entire installation should be inspected every month or so for the first six months of operation. While many stove makers advise you to use furnace cement as well

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Ten wood-burning stoves compared

Name	Size (HxWxD; in.)	Max. log length (in.)	Shipping weight (lbs.)	Loading-door opening (in.)	Stovepipe diameter (in.)	Firebox capacity (cu. ft.)	Est. max. output and/or heating capacity	Est. max. burn time (hr.)	Approx. retail price
Ashley C-60	36¼x35x21¼	26	247	9x13	6	4.5	10,000 cu. ft.	16	$300
Defiant	32¾x35½x23	23	350	8½x14½*	8 or 7	3.7	9500 cu. ft.	14	545
Jøtul 118	30¼x14x31¼	25	231	7x9	4.9 (125 mm)	2.2	44,500 Btu/hr., 8000 cu. ft.	14	490 black 550 green
Jøtul 4	41½x21½x20	19	286	13½x15	7	2.8	51,000 Btu/hr., 9000 cu. ft.	16	685 black 800 green
Lange 6302K	50½x16x34	25	370	7½x10	4.7 (120 mm)	2.4	9500 cu. ft.	14	n.a.
Morsø 1BO	51¼x14¼x30¼	22	365	7½x9¼	4.7 (120 mm)	2.3	9500 cu. ft.	14	670
Morsø 1125	41¾x14¼x22¾	21	354	12¼x20*	8	4.1	12,000 cu. ft.	19	650
Norwester C-76	34x18¼x29	19	140	8x14*	6	2.0	45,000 Btu/hr.	12	312
Riteway 37	40x24x33	24	400	11½x11½	6	7.5	73,000 Btu/hr.	36	425
Warm Morning 701	33¼x36x18	26	290	10x12	6	3.5	10,500 cu. ft.	13	511.50

Most of the information in this table was provided by manufacturers and/or distributors of the stoves. Since reliable maximum- and minimum-output figures for wood-burning appliances are very difficult to obtain, and test methods used to obtain them may vary, the figures should be viewed only as a rough guide. They are mostly quite conservative, especially for a house that is well insulated. The same holds true for estimated maximum burn time. Depending on temperature, wind, and atmospheric conditions, you may get a longer or shorter burn. And, of course, a lot depends on the type and dryness of the wood used. Maximum log length was determined with wood placed flat and at right angles to the sides or front of the stove, depending on manufacturer's recommendations. Door sizes marked with an asterisk are estimated effective, usable sizes of nonrectilinear doors. Finally, there are many other relevant features of wood-burning stoves not covered in this table. Perhaps the most important is appearance. Since wood-burning stoves are almost invariably used as area heaters, and will be in full view most of the time, you'd be wise to pick one you don't mind looking at.

in terms of wood stoves (as opposed to wood kilns and furnaces), the efficiency of secondary combustion remains in doubt, and some experts assert that actually it seldom occurs.

What does this all mean in practical terms? If secondary combustion occurs at all, it evidently occurs only at specific times. At other times an open secondary air inlet acts as any other air leak in the stove body: It reduces overall efficiency. Therefore, I advise potential buyers of stoves with this feature to make sure that these inlets can be closed manually (as in the Defiant) or automatically (as in the Ashley C-60). Also, because reasonably high temperatures are required to ignite any residual gases, secondary air inlets should be located reasonably close to the main flame front. Finally, stoves lacking any special secondary air inlet should obviously not be downgraded on that account.

The Scandinavian stoves included here incorporate single "twin-port" air-inlet (draft) controls, which some distributors refer to as primary and secondary in deference to this dubious distinction.

All 10 stoves covered here were carefully selected from among the dozens of wood stoves on the market, and all qualify as superior products. This is not to say that there aren't other fine wood stoves on the market; just that the time and space required for careful analysis precluded my covering additional stoves.

The only other criterion I used in assembling this list was that of heating capacity—all are medium- to large-size units capable of heating a small house, and a few (see table) can do a creditable job of heating a well-insulated medium-size house.

The 10 stoves I examined fall into two distinct categories: the "manually controlled Scandinavians" and the "automatic Americans." Although neither variety is exclusive to its place of origin (there are many manual American stoves as well as automatically controlled imports), the two types do accurately reflect their origins' prevalent design concepts.

The Americans

The basic idea behind an automatic wood stove is to regulate the air-intake control (or, less commonly, a damper in the flue pipe) by means of a bimetallic coil similar to the one found in an ordinary thermostat. The coil is basically a helix that winds tighter or unwinds in response to temperature changes. It's attached to the draft (air inlet) control by means of a rod or chain. Once you set a dial on the thermostat to a specified heat setting, the draft control will automatically open wider if the fire dies down. If the stove's heat output becomes too great, the draft control automatically closes, thereby regulating the indoor temperature. This presupposes that the automatic stove is fitted with an automatic control system that's the "continuous" type.

Among the American stoves covered here, only the Riteway employs a different system: a thermostatic draft control that's pulled open by a chain and pulled shut by a magnet. Depending on the regulator setting (1 to 15) and the condition of the fire, the Riteway's draft control is either open or shut automatically with no in-between settings. The manufacturer claims this system results in greater combustion efficiency and less crusty black creosote accumulations in the stovepipe and chimney. I am not yet prepared to judge the accuracy of this claim, but it is evident that both the continuous and "on-off" types of regulation work quite well.

In general, automatic wood stoves are very much in keeping with the American penchant to "set it and forget it," and they do tend to minimize heat fluctuations, one of the less agreeable characteristics of heating with wood. However, you cannot expect to start with a cold stove, light it, load it up, and immediately set the regulator to "medium." You must first perform whatever operations are necessary to produce a hot bed of coals, and then see that the fire is propagated to your full load of logs before you can expect the thermostat to function properly. Also, no thermostat can be expected to maintain a high heat output when the fuel is nearly exhausted. All five American units

[Continued on page 156]

as three #7 sheet-metal screws at each stovepipe joint, I recommend only the latter because cemented joints discourage frequent inspection.

- At least once a year, do a thorough job of cleaning your chimney, stovepipe, and stove interior if necessary.
- Be careful with ashes: They are an excellent insulator and can conceal hot coals for long periods. Dump them only into a noncombustible metal or heavy ceramic container; one with a secure top is best.
- Make sure that your chimney is either a flue-tile-lined one in sound condition or a UL-approved prefabricated insulated chimney. The inside diameter of a round chimney must never be smaller than the stove's stovepipe collar.
- Install a smoke detector in any wood-heated home.
- In the event of very high winds or logs that snap, crackle, and pop excessively, turn the draft control down and keep a watchful eye on the unit.
- Be sure no highly combustible materials are kept near a wood stove, especially near the air inlet.

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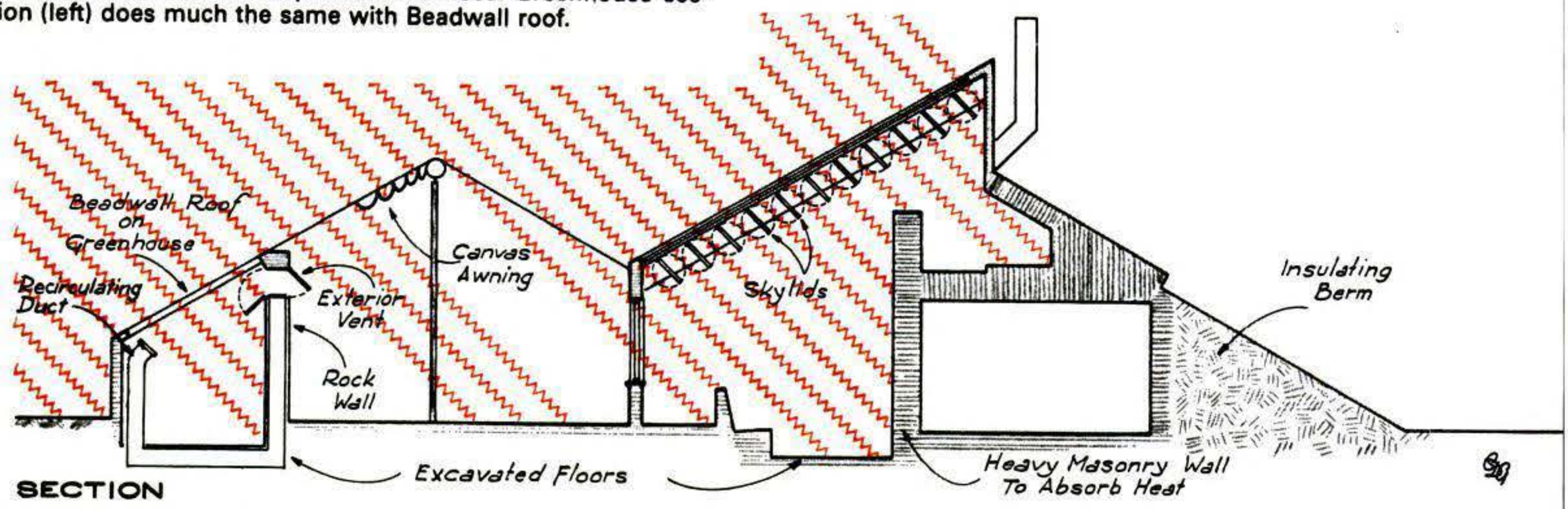
PS LEISURE HOME of the month

Sun trap

Each element soaks up sun a different way. Glass-roof house has pivoting louvers that let rays strike central masonry wall; at night, louvers close to prevent heat loss. Greenhouse section (left) does much the same with Beadwall roof.



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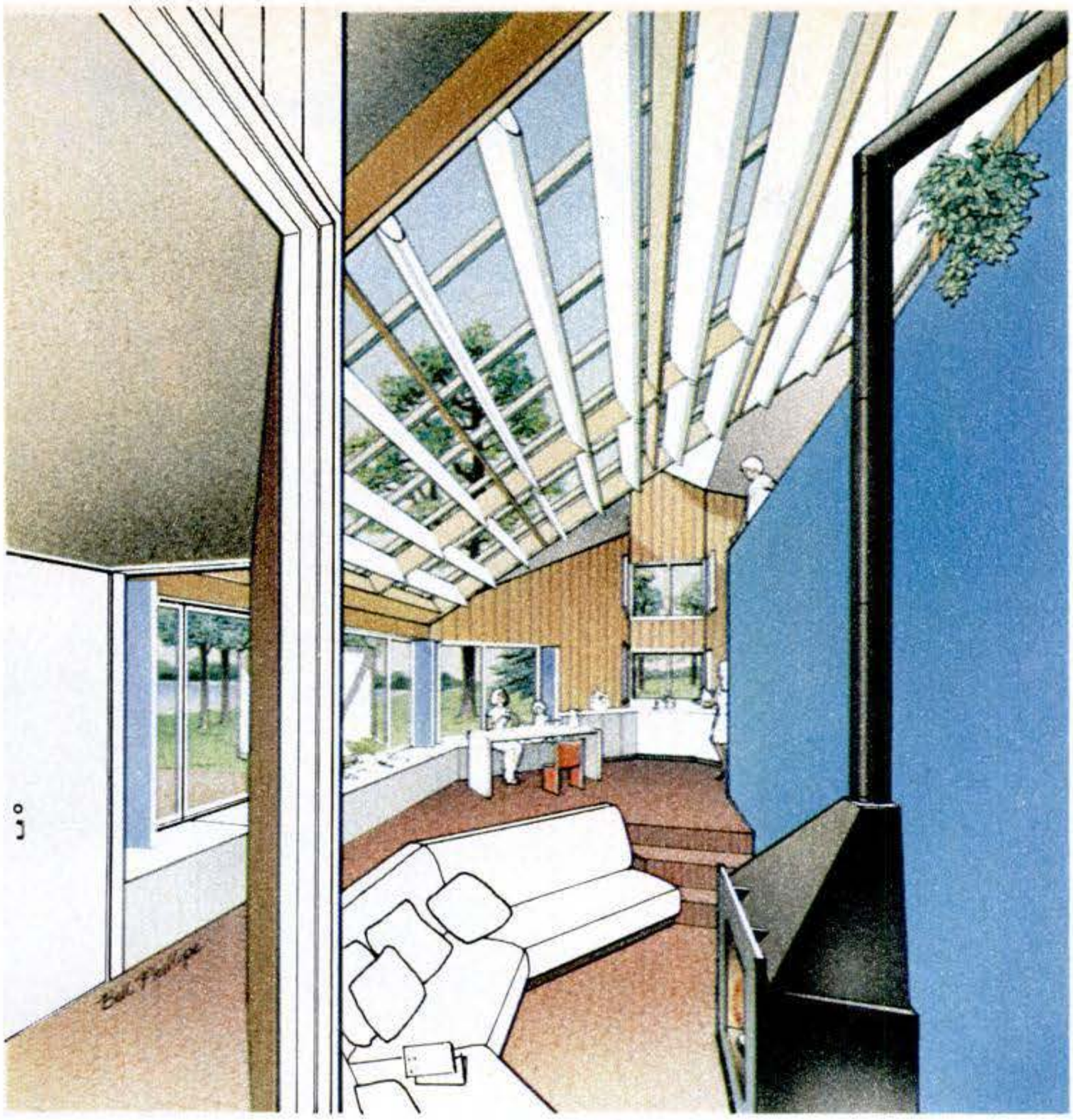
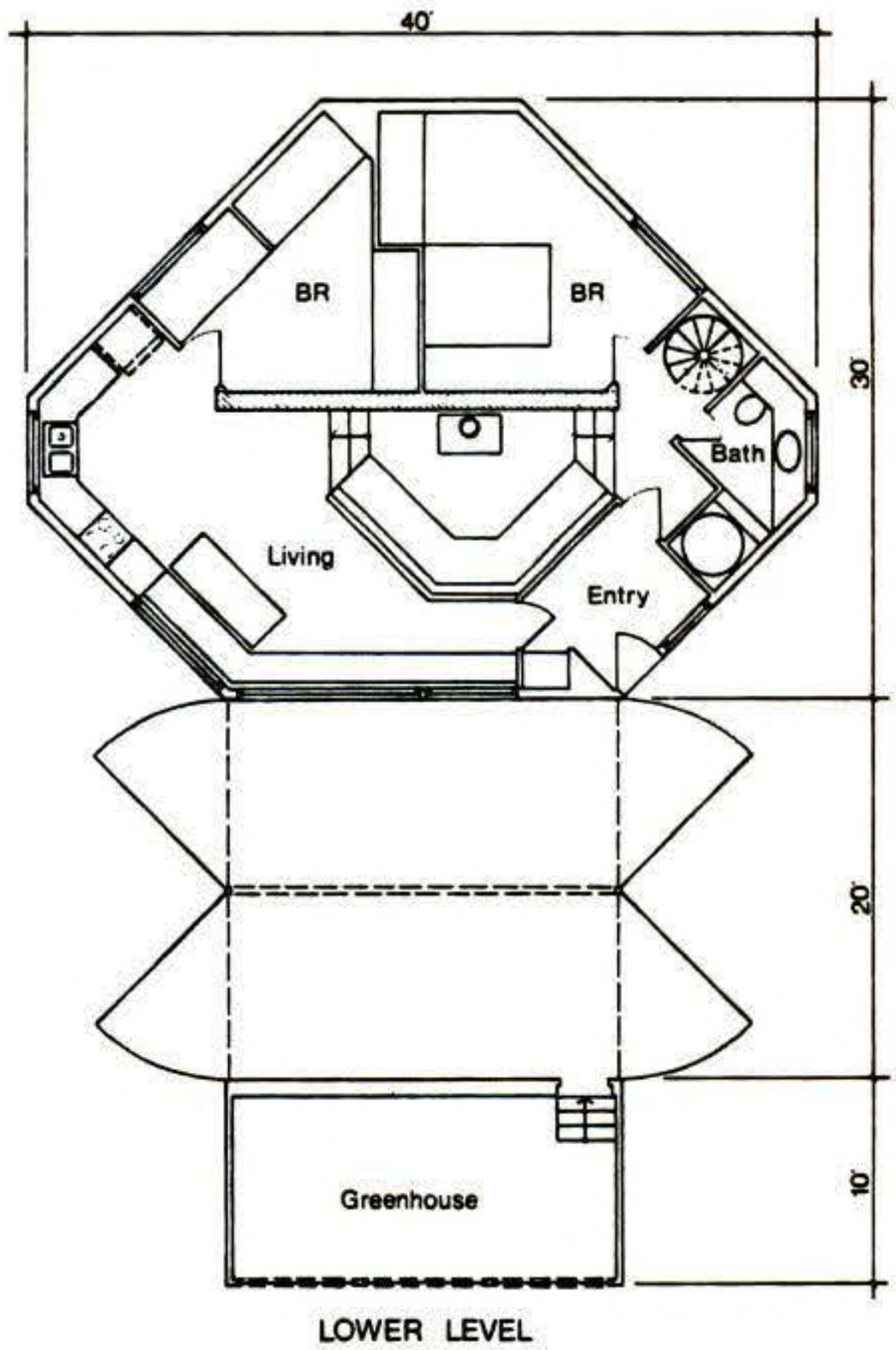
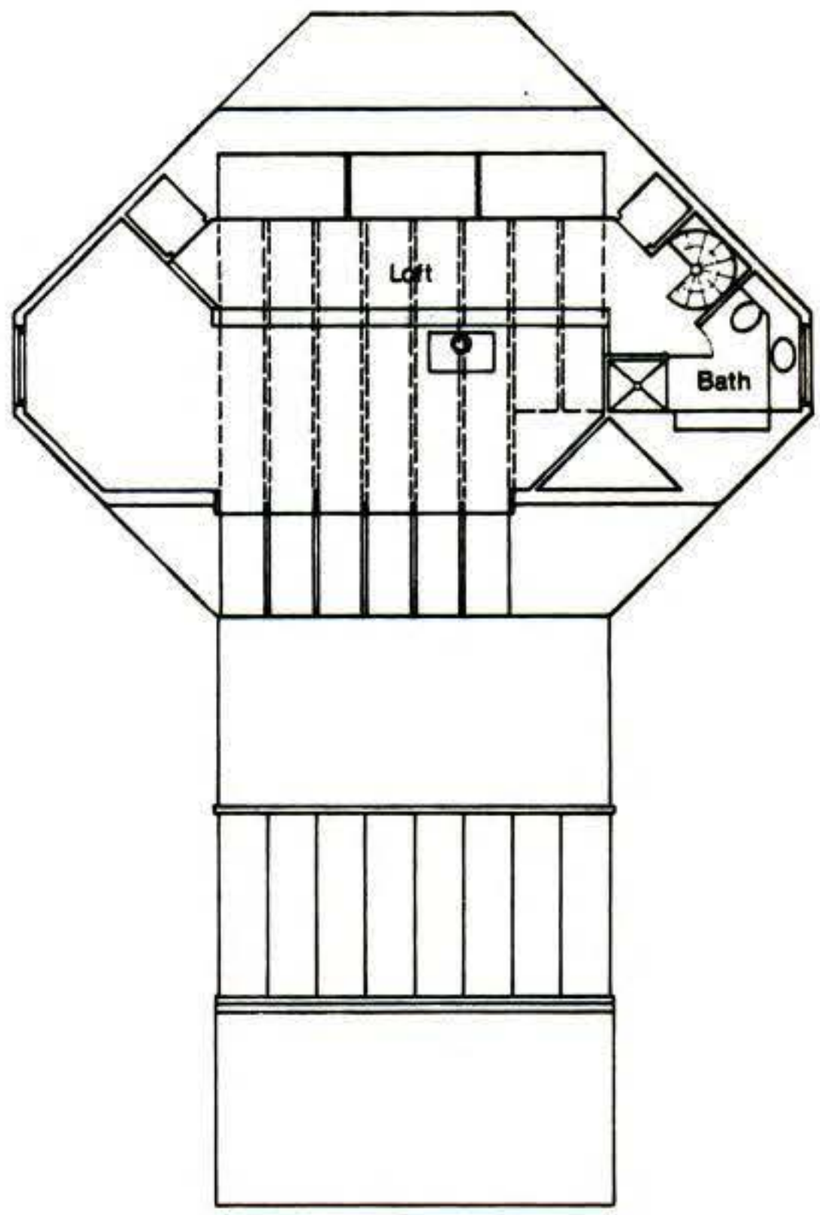




LOWER LEVEL



UPPER LEVEL

Here's the passive solar house you've asked us to do. Prize-winning architect Alfredo DeVido offers PS readers complete plans

By AL LEES

"How come," runs a typical letter about the plans in this series, "you promote energy-conscious homes on your covers but don't incorporate major systems into your *leisure-home* plans?" Or: "Why not ask an architect to design a solar vacation home from the ground up?"

We couldn't think of a better man to ask than Al DeVido, whose designs for a pair of solar houses caught our eye in a 1976 issue of *Building*.

"Plan a passive solar house for us," we said, "with elements that serve as their *own* collectors, so you don't need elaborate systems."

The house that meets all these requirements turns out to be as delightful inside (above) as outside. It's a tight 900-sq.-ft. structure to be sited as near due south as possible to expose maximum wall and roof surface to the sun. Its windowless north wall prows into an insulating berm formed with earth excavated from the sunken seating area around the fireplace. This brick-paved recess traps radiant heat from the fireplace, which is a circulating type with its metal liner left exposed.

The glass roof over this living area focuses the sun on a masonry wall (stuccoed concrete block in our rendering but it could be native stone) that retains the heat and reradiates it during the night. An automatic louver system (the commercial name: Skylids) closes off this glass at night to conserve the stored energy. (The louvers can also be closed to block unwanted heat gain in summer.) An airlock entry prevents drafts and heat loss.

Adjacent to the entry wall is a versatile patio area with corral-type gates that swing open to summer breezes but close to trap the sun the rest of the year. They double as privacy screens for sunbathing or patio entertaining. Supported by the gateposts is an adjustable canvas awning.

Closing this area to the south is a greenhouse with an insulating fiberglass roof operating on the Beadwall principle: Opaque plastic-foam beads are sucked in and out between the double glazing (they store in a tank inside the greenhouse). The sun heats a pebble wall during the day, and this heat is recirculated at night by means of an underground duct and a small fan. PS

Here's how to order plans

Architect's working drawings that permit you (or your contractor) to build the PS Sun Trap are available from Alfredo DeVido, 27 West 53rd St., New York, N.Y. 10019. A single set of plans is $60; four sets are $75. A complete materials list, including sources for the Skylids and other special materials, is $10 with a plans order. Orders sent first class. Make checks payable to Alfredo DeVido.

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Mask that peeling paint with **soffit covers**

Did ravages of last winter leave scars like this on your soffits and fascias? Cover them before the first new snow.

To yank long nails through roof gutters without any damage, try welding claws from an old hammer to an impact puller.

Metal shield helps prevent accidental battering of J-channel that supports inner soffit panel ends. Predrill nail holes.

It pays to experiment before trimming all panels to length. Above, lack of square panel ends means piece must be recut.

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Cover soffits and fascias with metal or vinyl, and you'll never repaint them again

By E. F. LINDSLEY

Ask any house painter about soffits and fascias and he'll quickly inform you that they're just about the most miserable surfaces ever contrived to paint and maintain. Soffits are the undersides of the roof overhang on your house. Fascias are the facing boards on the ends of the rafters and are usually semiconcealed behind the rain gutters. They're tough to keep from peeling and rotting, because the fascias get all the overflow from the gutters, and ice can be trapped against them for weeks in the winter. The soffits enclose narrow interior spaces and are often poorly vented, so they collect moisture inside that soon loosens the paint outside.

Once the peeling starts there are two answers—neck-wrenching scraping and painting, or covering the offending wood with permanently finished aluminum or vinyl.

After 10 years of fruitlessly battling against yearly peeling I took note of what Sears calls "Aluminum Overhang." These are preformed, prepainted aluminum panels that you buy in the approximate size to fit the overhang on your house.

Sears says that do-it-yourself installation may be "easier than you thought." It may also be tougher than you thought, but it's not really beyond ordinary skills. Incidentally, this job can be done even if your house now lacks a box soffit and has bare rafter extensions and roofboards showing.

The instructions included with each package tend to be skimpy and overlook real-world problems. What, for example, do you do with the roof gutters while you're working? Mine were too good to discard, in spite of needing paint, and were firmly soldered into one long 62-foot run that didn't seem adaptable to total removal without causing damaging buckles. I solved this problem by building 2"x4" extension supports that allowed the gutters to be moved out far enough to work behind them.

Another problem for which Sears and Reynolds Aluminum had no real answer was the presence of two moldings common to older houses although not so common on new homes. One was at the juncture of the soffit and the wall. This I pried off, and the J-channel that supports the inner edge of the panels partially covered this area. The stickler was a heavy molding right up at the angle where the fascia and the overhanging shingles and drip flashing join. When I stripped this away I lost the seal at this point and had no support for the shingle overhang.

I found that at my local store I could buy Macklenburg-Duncan aluminum angle that would act as a seal and a support for the shingles. Before screwing this channel into place I shot a heavy bead of caulking into the corner so the angle would squish down on it and make a watertight joint.

I later discovered that if I'd been using vinyl material instead of aluminum, I could have saved all this trouble with ready-made moldings offered by the manufacturers. Another advantage of a vinyl system: The color goes all the way through so vinyl never needs repainting. The finish on the aluminum might eventually call for recoating.

I ran into a few other problems:

- The nails supplied with the kits simply couldn't be driven into the old, hard-yellow-pine soffit boards.
- Unless you're an expert at standing on a ladder and hammering upward and backhand with perfect accuracy, you find yourself denting the soft aluminum badly.
- The soffit sheets had to be trimmed about 5/8" to fit my 18" soffit. Theoretically, I should have been able to mark each piece with a gauge and trim. Unfortunately the ends of the sheets were as much

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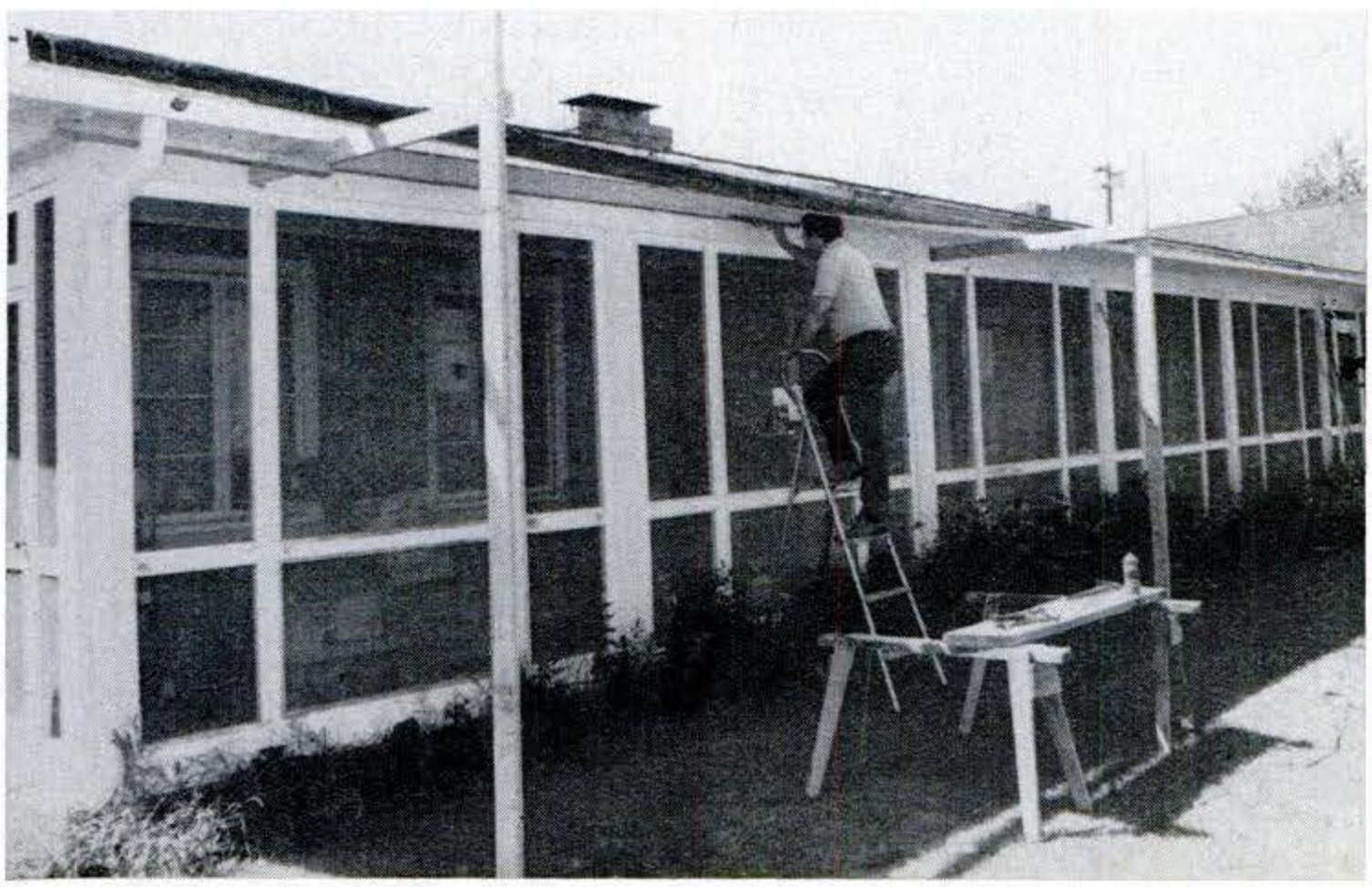
Since fascia lip is only long enough to overlap old board by 1/8", try using a sheet-metal screw in V of each panel.



Scrap of steel bar helps drive nails home without denting soffit panels. Author predrilled nail holes in hard boards.

Long welded gutter was impossible to take down without damage, so author built outriggers to slide it out of way.

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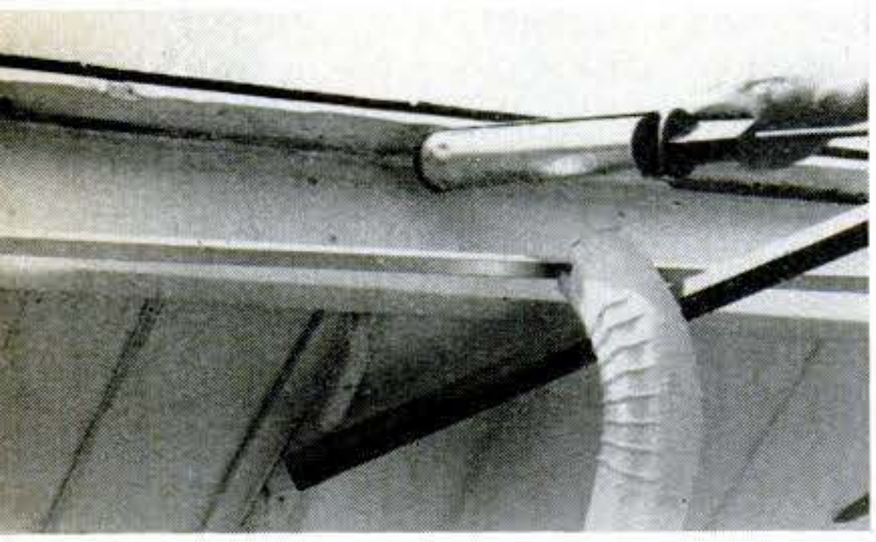
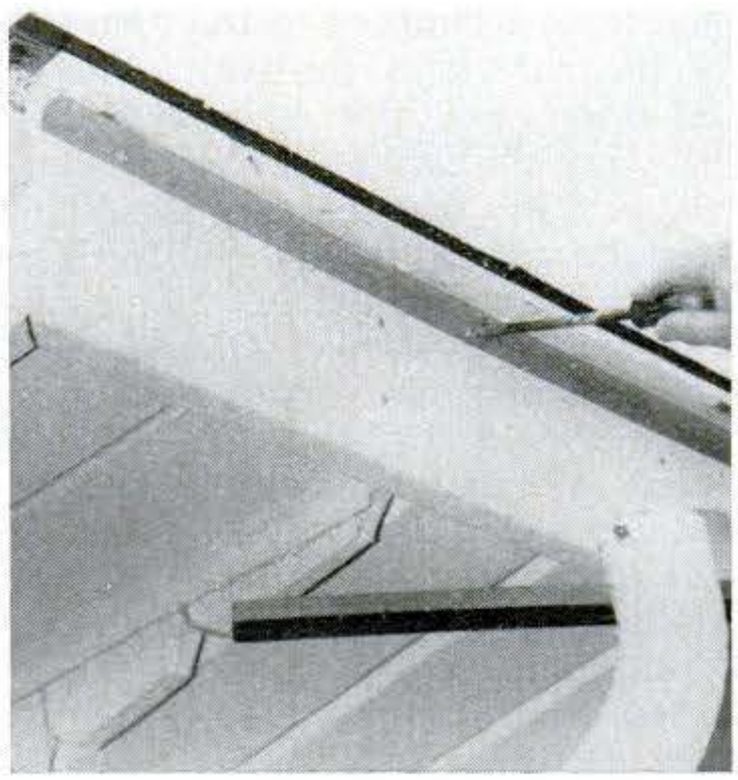
Aluminum soffit panels are in place at right, awaiting fascia to cover edges and peeling mess behind tipped-up gutter.

Six-inch fascia panels fit well and were overlapped 2", but this left no seal where molding had been under drip flashing.



Caulking compound is applied liberally to fascia/roof juncture above the fascia panels before metal angle is applied.



Sheet-metal screws draw angle down to bond upper edge of fascia. Vinyl systems have ready-made molding for this.

Vinyl system (this is Mastic's T-Lok) has somewhat different edge interlock and may be easier to install and nail. You still have some customizing to do.

as 3/16" off square and it was necessary to square each piece before fitting. After checking on this with Sears and Reynolds I was told that two degrees off square was within industry standards and that I should have enough overlap in the J-channel and fascia lip to allow the panels to be shifted and still cover the off-square ends. I could only gather that Reynolds hadn't counted on the thickness of the original fascia board, which gave me only about 1/8" lip to work with and made it impossible to live with out-of-square panels.

The nail problem was easily solved by predrilling the holes and by substituting spiral-groove nails that were shorter and stiffer. Predrilling also helped me get the panels placed squarely, since I could align, drill, and drive without the sliding around that occurred when I nailed cold turkey.

To prevent denting I used a metal shield to keep the hammer from whacking the edge of the J-channel. I set the nails that hold the soffit with a piece of 9/16" bar stock to keep the hammer away from the panels. In a few tight spots I drilled and used sheet-metal screws.

Aluminum soffit material may be trimmed with a carbide blade in a table saw, a metal-cutting blade in a band saw or saber saw, or with snips. I found it easiest to trim with a pair of old-fashioned tinner's snips. A pair of right- and left-hand aircraft snips helped on the occasional fancy nips.

I also worried about what was going to happen to the wood behind the bright, new metal. It would still suffer, I felt, from some unseen condensation, so I coated all the bare surfaces and end grains with penta wood preservative.

My soffits are vented to the attic by screened vents inside; but lacking good ventilation, you should install perforated vent panels every six feet or so.

Metal soffits and fascia are not particularly inexpensive; I used about $330 worth of materials on my back porch, which worked out to about 80 lineal feet with a smidgen left over. On the other hand, doing the work yourself saves quite a bit, and the freedom from unsightly peeling and rotting—and from repainting chores—makes this a very fair long-term investment.

You'll find the aluminum material in Sears Home Improvement Catalog. For information on Mastic Corp.'s vinyl material, write to Mastic Corp., 131 South Taylor St., South Bend, Ind. 46624. PS

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Self-contained module lets you build your own **digital clock**

In-the-wall kitchen clock is out of the way, but easily accessible for time checks and setting alarm-timer buttons.

Solder a few wires for a versatile timer-alarm

By KRIS JENSEN

How would you like to spend an hour or two building your own digital clock, complete with snooze alarm, a.m./p.m./power indicators, and an extra circuit to start your morning coffee?

You can, thanks to a large-scale-integration (LSI) integrated-circuit chip, which is combined with a digital light-emitting diode (LED) to make an entire clock module. All you do to make it work is solder on a few leads for power and switching.

We tried it as an in-the-wall kitchen clock, and, with a Plexiglas container, as an addition to a night-stand. But its small size (the module measures only ¼″-by-⅞″-by-3″) allows it to fit in virtually anywhere.

The clock module (model MA 1002A), made by National Semiconductor, comes prebuilt; you add

Continued

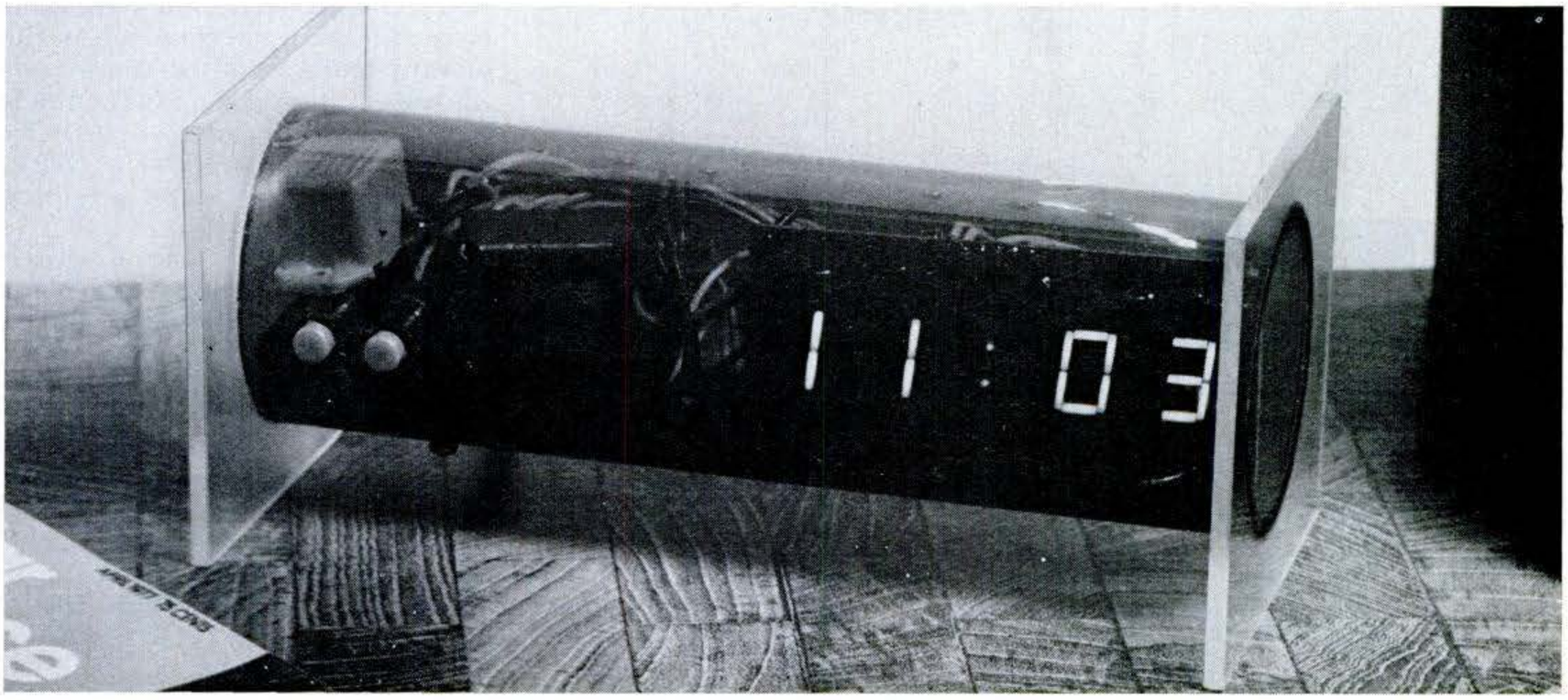

Table-top design is contained in Plexiglas cylinder. Miniature module leaves plenty of room for your imagination.

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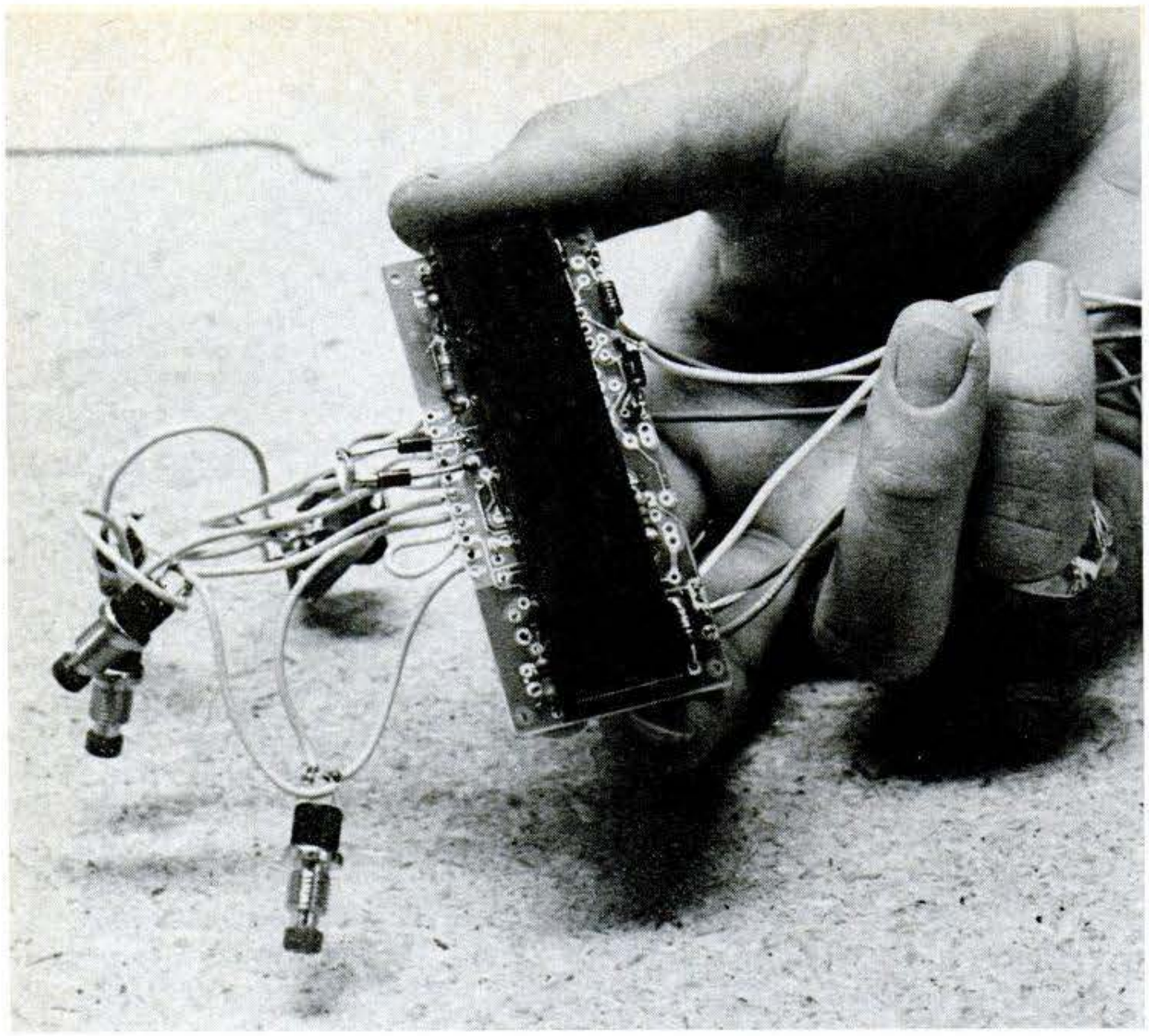
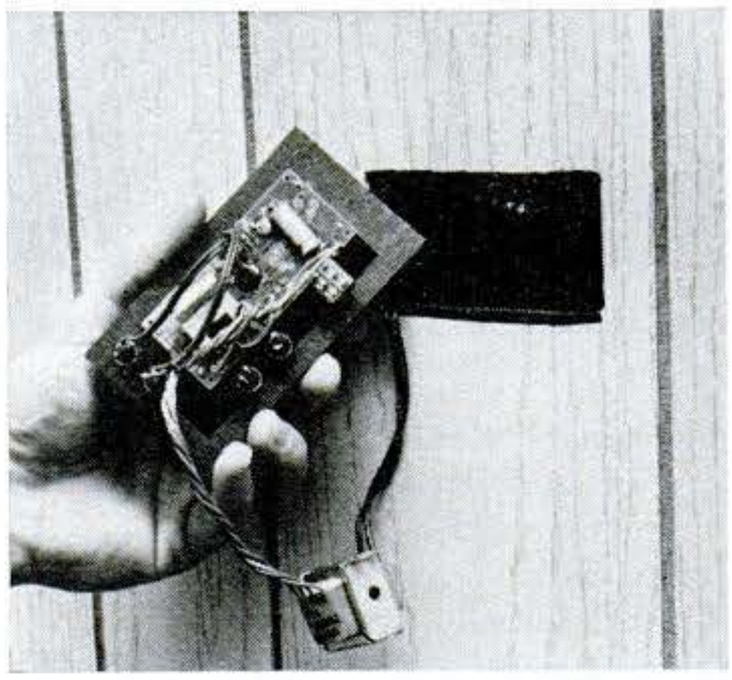
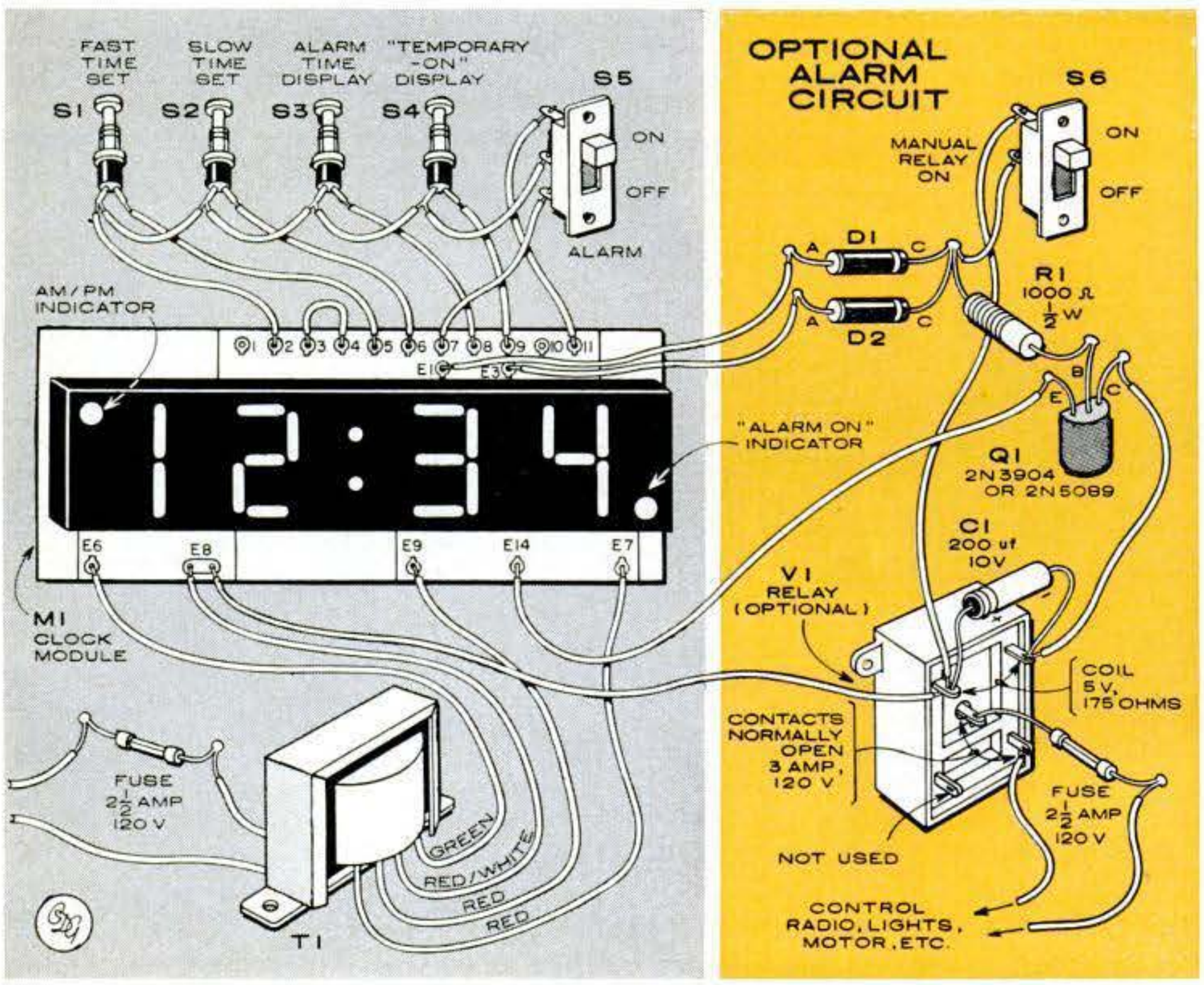


Entire clock shown above comes prewired on a printed circuit board—all you do is add the switches, transformer, and optional circuit as shown in the diagram. For in-the-wall installation simply glue the plastic display enclosure on the module to smoked or red Plexiglas. Holes are drilled for the front pushbuttons. Layer of masking tape shrouds rear surface so display alone is seen. A three-inch-diameter Plexiglas tube is used on the table clock; drill small holes in the rear for heat dissipation. If you intend to seal it with glue, be sure all connections are tight.





only the control switches, power transformer, and—if you want it to turn something on or off—an optional control circuit. Solder wires shown in the drawing, using care not to overheat the mini push-button switches or the circuit board.

If you want to add the extra components for on/off operation of some appliance (controlled by a built-in alarm circuit), mount the two diodes, resistor, and transistor on a terminal strip for support and wire it as shown.

When first switched on, the clock display will blink on and off. This is to indicate an incorrect time being shown (or to let you know of a power failure). Pressing the fast-time button will advance the display by about an hour every second. Pushing the slow-time set advances the display by a minute per second. And, for each 12-hour period, another indicator will light for either a.m. or p.m. If it's 1 p.m., for example, advance the clock to 1:00 with the indicator lit. If it is 1 a.m., however, advance it to 1:00 with the indicator off.

To set the alarm time, press and hold the alarm-time display button and use the fast- or slow-time buttons as before. The display then shows the time at which the alarm will sound. The alarm-set button is also the snooze button—hit it after the alarm goes off and you get nine minutes of extra sleep before the alarm automatically sounds again.

Pressing the temporary-on button displays how long the alarm will sound once it's actuated (up to 59 minutes). This too can be set with the time-set buttons. The alarm on-off switch resets the alarm.

These buttons act as a time reminder for you without additional circuitry. The optional circuit causes a relay to close when the alarm circuits from the clock module are actuated. Using the contacts of the relay, it can then actually sound an alarm, start your coffee, turn on a light—control anything you've got connected to it.

The extra switch for this circuit is simply an override for the alarm circuitry of the module; you can turn on a device manually by throwing the switch. It will have no effect on the module's alarm-set.

Parts for the system, including the module, are standard; they're available through most electronics-parts houses. They are also available as a kit from Digi-Key Corp., Thief River Falls, Minn. 56701. Basic clock components are $14.95; a second set of parts, with optional alarm circuitry, is $17.95. PS

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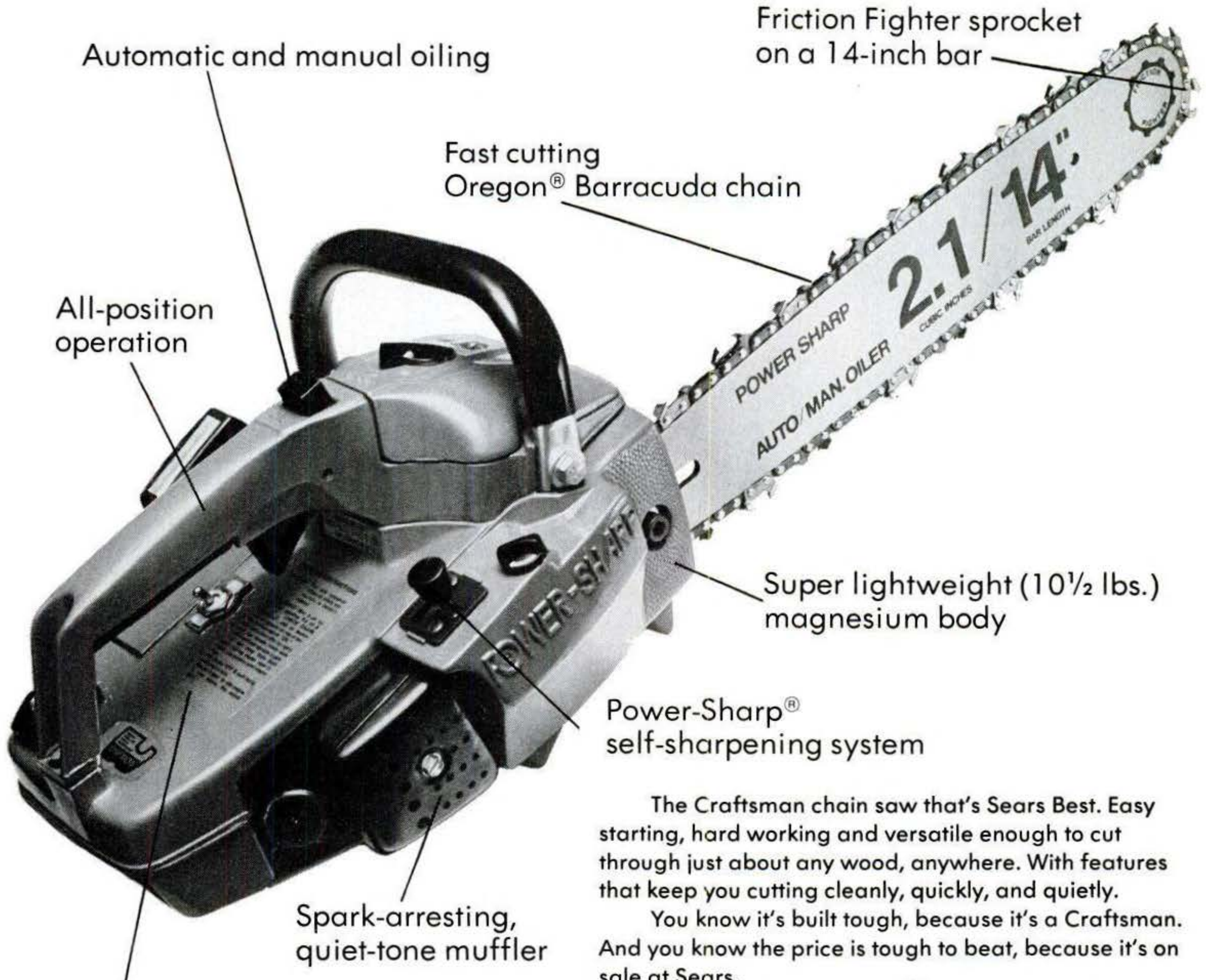
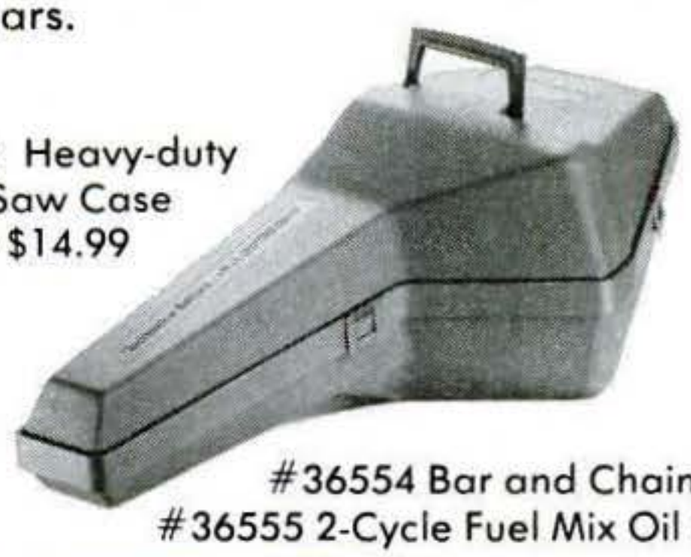
Save $50 on the chain saw tough enough to be called Craftsman.



The Craftsman chain saw that's Sears Best. Easy starting, hard working and versatile enough to cut through just about any wood, anywhere. With features that keep you cutting cleanly, quickly, and quietly.

You know it's built tough, because it's a Craftsman. And you know the price is tough to beat, because it's on sale at Sears.



#36622 Heavy-duty Chain Saw Case Only $14.99

#36554 Bar and Chain Lubricant and #36555 2-Cycle Fuel Mix Oil also available.

Save $50.00

Now $149.99

Hurry. On Sale October 30 through November 27, 1977. Available at most Sears stores. Prices slightly higher in Alaska and Hawaii.

Sears CRAFTSMAN®

Tools that have earned the right to wear the name.

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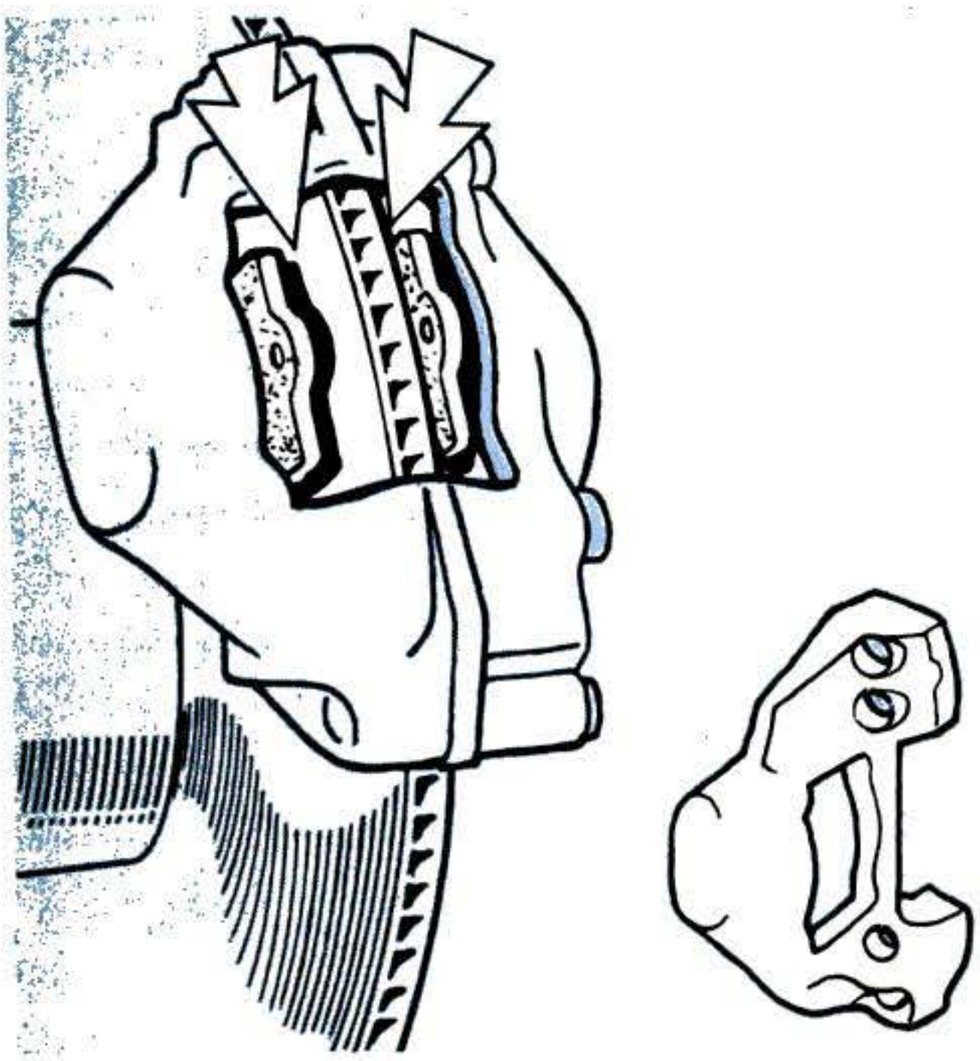
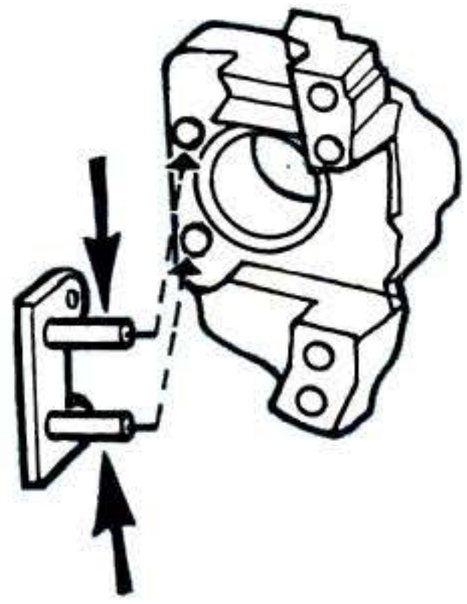
TAKING CARE OF YOUR CAR

By
RICH CEPPOS

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.



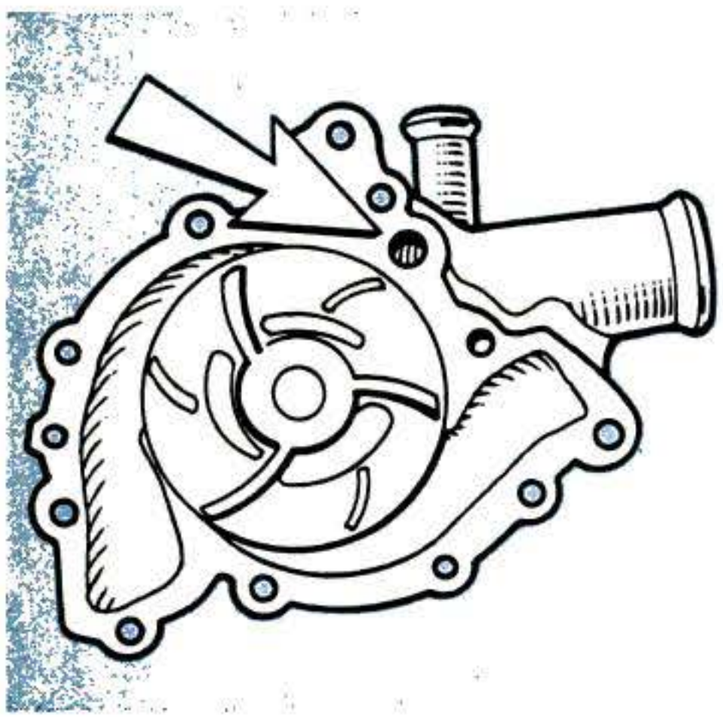


Repairing frozen calipers

If your car's equipped with sliding-caliper disk brakes and you're getting excessive brake-pedal travel, you could have frozen calipers. Check the pads; if they're not in full contact with the disks, then the caliper isn't sliding to compensate for pad wear. The fix: Disassemble the calipers and remove the sliding plate (arrow). This may require use of a wood block and a hammer. Clean the plate pins and caliper-housing holes with solvent to remove grit, lubricate the pins sparingly with grease, and reassemble. Be sure to tighten all bolts to specified torque.

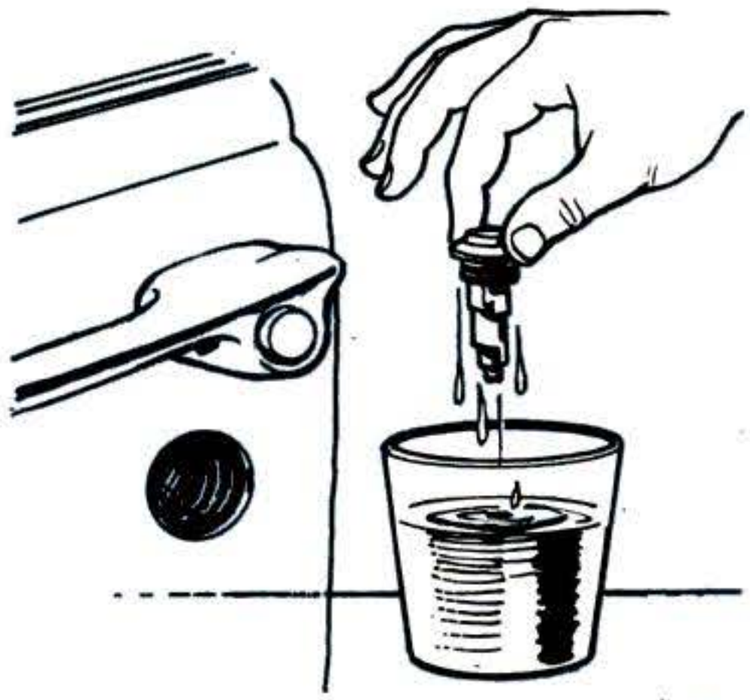
Pop dents out

One of the best tools ever created for removing dents from soft, vulnerable spots like doors and quarter panels is your hand. Remove inner panels or other obstructions, and use the heel of your palm to pop dents out. Filling and painting work will be minimized.



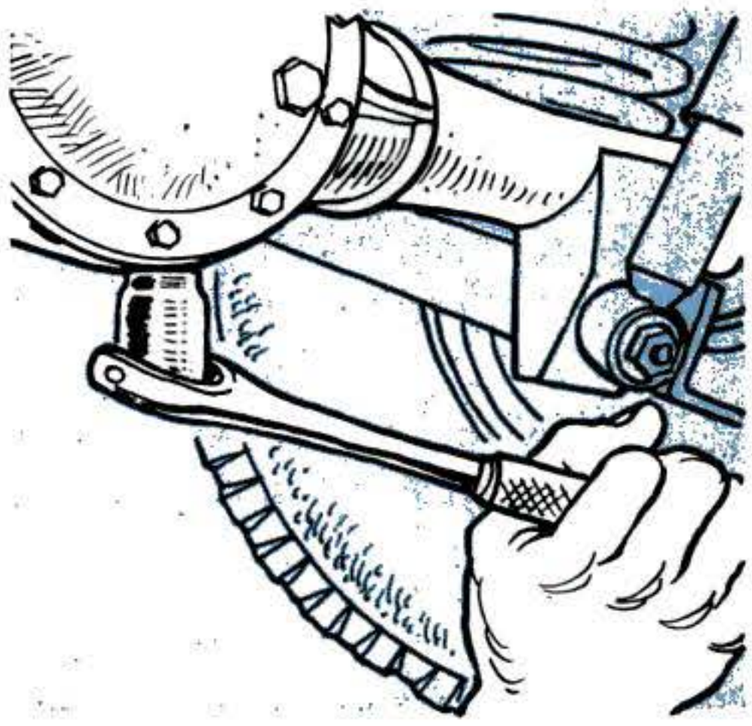
Removing water-pump blockage

On some GM cars equipped with the 231 V6 engine, you may hear a muted thump in the heater core and feel a pulsation in the heater hose. It may be caused by casting flash that's blocking the bypass passage of the water pump. Removing the obstruction should correct the condition. If the thumping still exists, the problem is a casting-flash obstruction in the cylinder-head water passage.



Anti-freezing door locks

Keep your car-door locks from freezing this winter with some simple preventive maintenance. Prepare a soupy slurry of lock lubricant by mixing one part Lubriplate Autolube-A with one part oleum solvent. Remove the locks and submerge for five minutes. If your car has power locks, remove the solenoid and lubricate its shaft above the rubber boot only. Liquid graphite will also work as a lubricant.



Stopping differential chatter

If your car's limited-slip differential chatters during tight turns, try flushing the lubricant. Drain the old fluid and refill with fresh lube. Raise both rear wheels off the ground and run the car in "drive" for four minutes at no more than 30 mph. Drain and repeat the sequence. If the problem isn't mechanical, the chatter should completely vanish by the time you've driven a hundred miles.

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Motorcraft Batteries.

If they're tough enough for Alaska, they're tough enough for you.

Fairbanks is just 120 miles from the Arctic Circle, in the heart of pipeline country. A rugged place to test auto parts.

To avoid start-up failures Alaskans leave their engines idling for hours. That's a continuous strain on battery power.

Some roads don't even look like roads. The pounding ride tests the rugged interior construction of Motorcraft batteries.

The Motorcraft Heavy-Duty Premium Battery. In the fierce cold, you need a strong and reliable battery to crank the frigid engines.

There's a word for the way Alaska treats batteries. Tough. That's why we took Motorcraft heavy-duty batteries to Alaska. And had an independent testing company test them in 50 privately owned Ford, GM and Chrysler cars and light trucks.

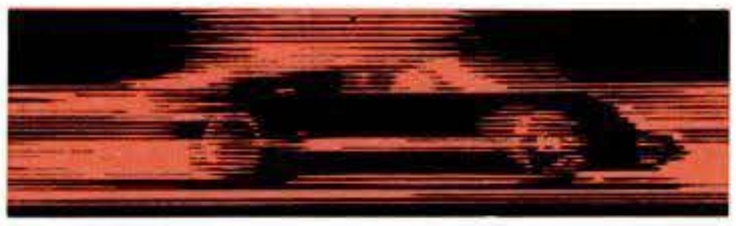
The batteries had to survive long periods of idling, the hard pounding on rock-strewn roads, and Alaska's astonishing temperature extremes...from way, way below zero to 90 degrees of summer.

The result? After six months of the rugged punishment Alaska dishes out, not one single Motorcraft battery failed. In fact, less than one-half of 1% of the 1674 Motorcraft parts in the test couldn't take it. That includes batteries, oil filters, shocks and tune-up parts.

Ford
75TH ANNIVERSARY

No matter what you drive... wherever you drive, ask for Motorcraft auto parts. They're tested tough in Alaska.

Motorcraft Ford



TESTED TOUGH

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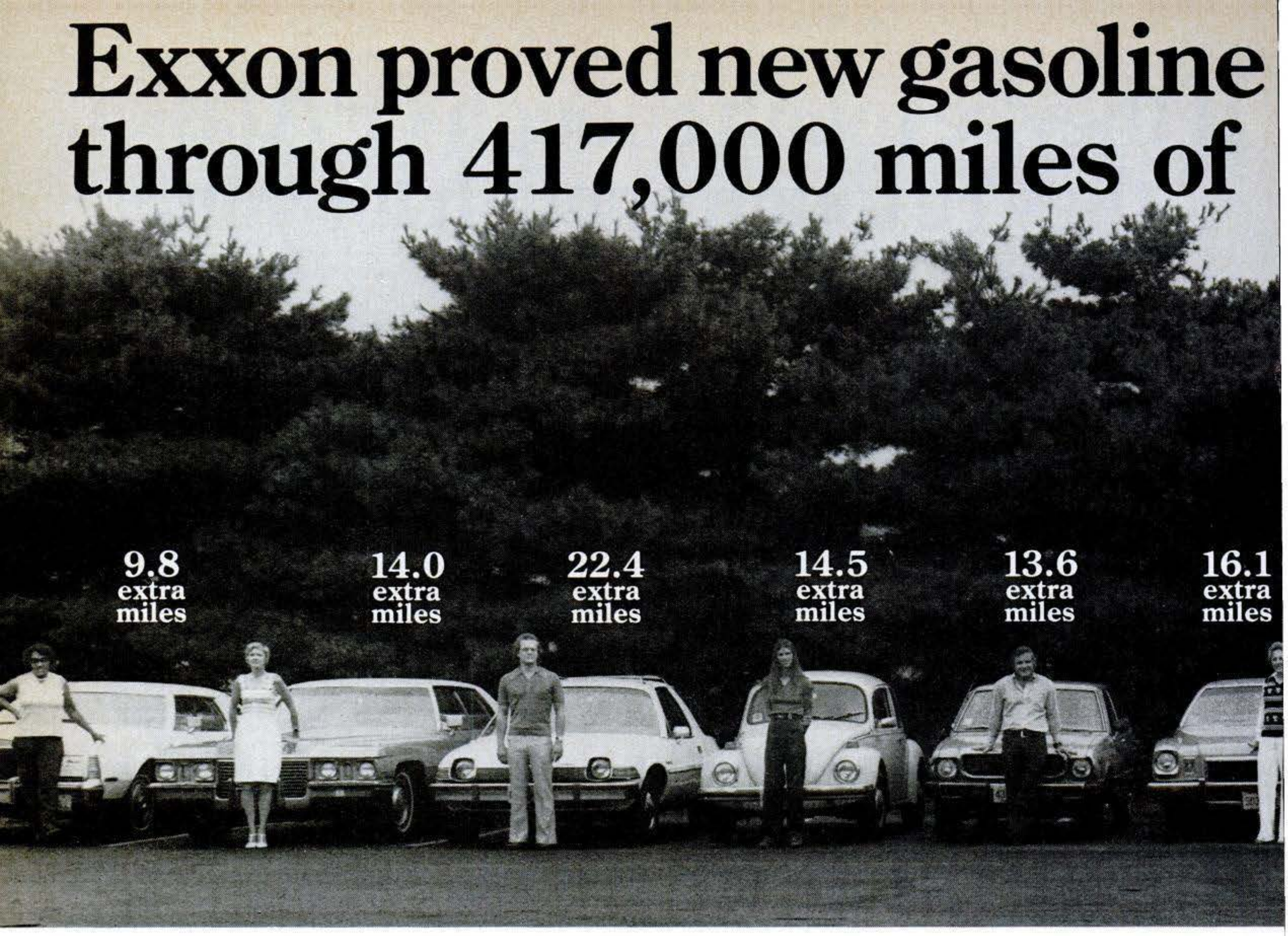
Exxon proved new gasoline through 417,000 miles of



New Uniflo gave an average 16 extra

It's hard to believe that changing to a new motor oil could give you more miles on a tankful of gasoline.

So Exxon proved new Uniflo motor oil through actual driving tests. In taxicabs. In police cars. In EPA-type fuel-economy tests on dynamometers. And finally this test:

417,000 miles of driving like you drive.

We compared new Uniflo and typical multi-grade oils in driving tests using a fleet of cars that logged 417,000 miles—114,000 of them on our new gasoline-saving Uniflo.

The 19 cars in this fleet were typical of cars you're likely to drive.

They ranged in size from a VW to a Cadillac.

People who were not professional drivers took all 19 cars over the same route, day after day.

They drove like you drive—in city, suburban and highway traffic—while we measured the gasoline they used. Here's what we found:

Compared with a typical high-quality multi-grade oil, new Uniflo demonstrated measurable gasoline

New from Exxon Research.

Free folder *tells how this new super-premium multi-grade oil saves gasoline. At your Exxon station. Or write New Uniflo, P.O. Box 2180, Houston Texas 77001.*

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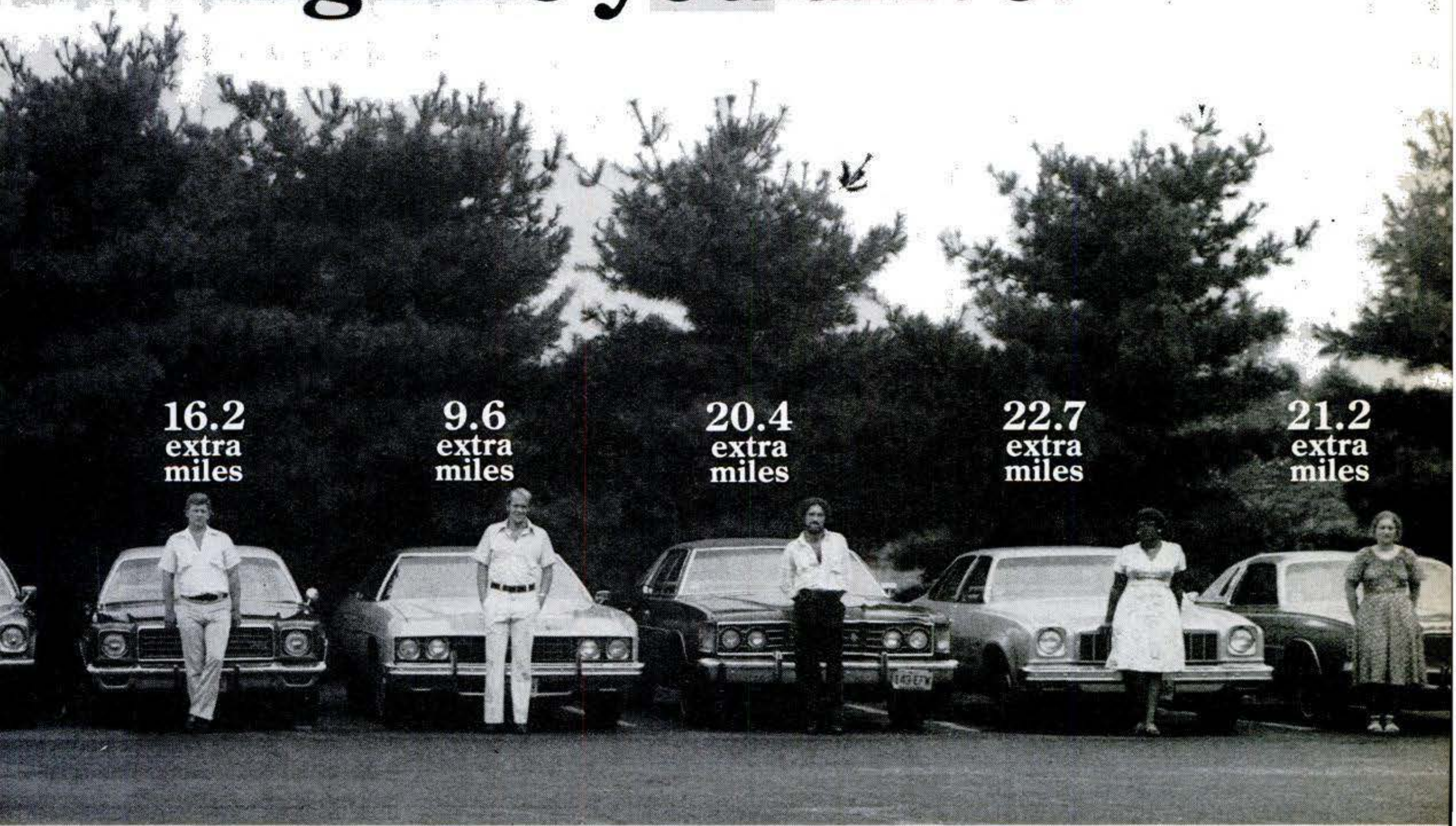
-saving Uniflo® motor oil driving like you drive.



Some individual car savings in one of our driving tests. Your results may vary, depending on your car and driving habits.

miles per tank of gasoline.

savings in 18 of the 19 cars—savings as great as 26 extra miles per tankful in one car.

And the whole fleet of cars averaged 16 extra miles per tankful of gasoline, after conditioning with new Uniflo.

How Exxon's new gasoline-saving Uniflo works.

Exxon Research has found a way to make this golden, natural oil lighten the load on a car's engine.

Unique, oil-soluble friction modifiers cut the resistance between moving parts, and let the engine put more horsepower into moving the car.

In an average car, the friction-reducing action of new Uniflo builds up gradually for about 1,500 miles as Exxon's new motor oil conditions the engine.

From then on, with new Uniflo there is measurably less drag in the engine than with typical high-quality multi-grade oils.

So the engine turns easier and needs less gasoline. And when you save gasoline, you save money.

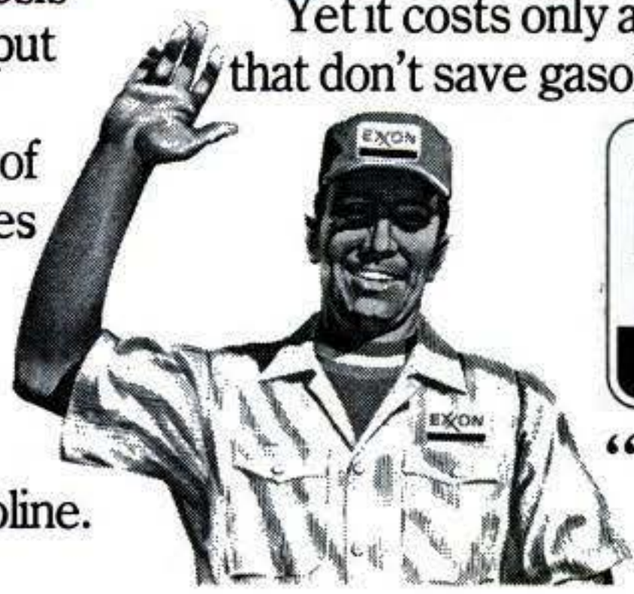
You could save the equivalent of about 3¢ a gallon on gasoline.

Gasoline savings of new Uniflo motor oil could reduce your gasoline costs the equivalent of about 3¢ a gallon.

And new Uniflo could save the country over 200 million gallons of gasoline a year, if just one out of every 20 cars used it.

New Uniflo is Exxon's best engine protection ever, with new, friction-reducing capability.

Yet it costs only a little more than multi-grade oils that don't save gasoline and money. Try it.



EXXON

"Thanks for coming by."

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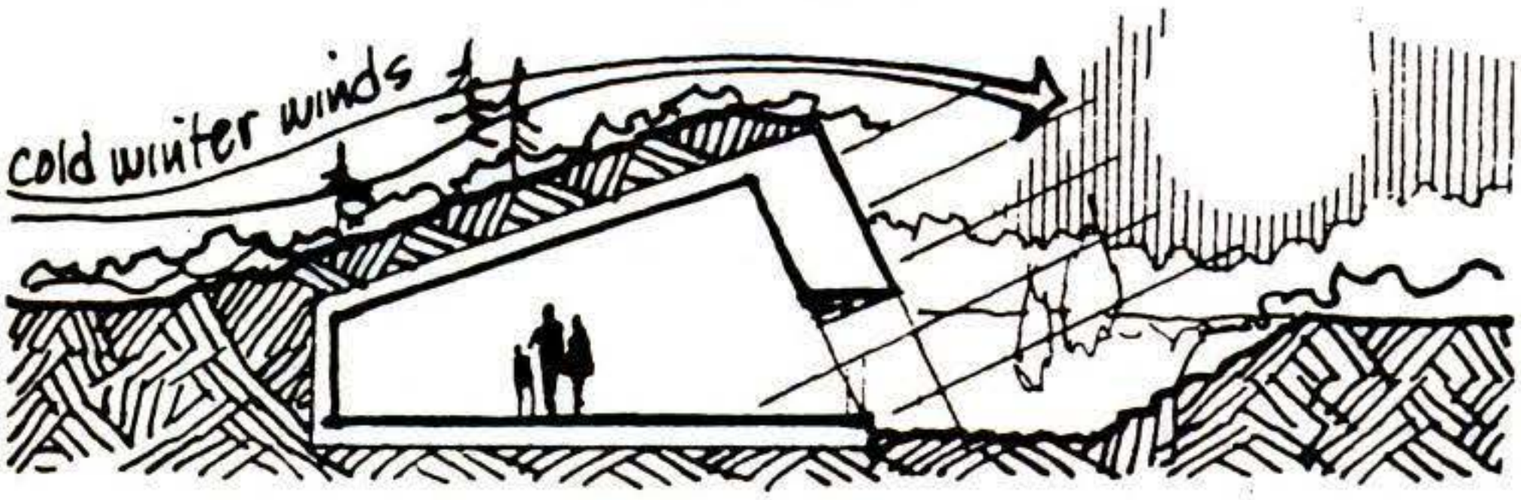
SHOP TALK

By RICHARD STEPLER



A book from underground

Readers who were fascinated by "Underground Houses—Low Fuel Bills, Low Maintenance, Privacy, Security" [PS, Apr.] should find a new book by one of their architects enlightening reading. *Underground Designs,* by Malcom Wells, is a collection of plans and drawings executed by the architect during his underground career. Included are homes, offices, townhouses, factories, a hotel, even an "organic mortuary."

"It surprises many people to discover that solar heating and underground architecture go so well together," says Wells. "But, after all, what could be simpler?" (See drawing above.) PS readers shouldn't be surprised, however. We reported on Solaria, one of Wells' earth-roofed solar homes, in "Solar Architecture" [PS, July '76].

Underground Designs also includes sections on codes, financing, waterproofing, and insulation. The 88-page paperbound book is $6 from Malcolm Wells, Box 183, Cherry Hill, N.J. 08002.

Play ball!

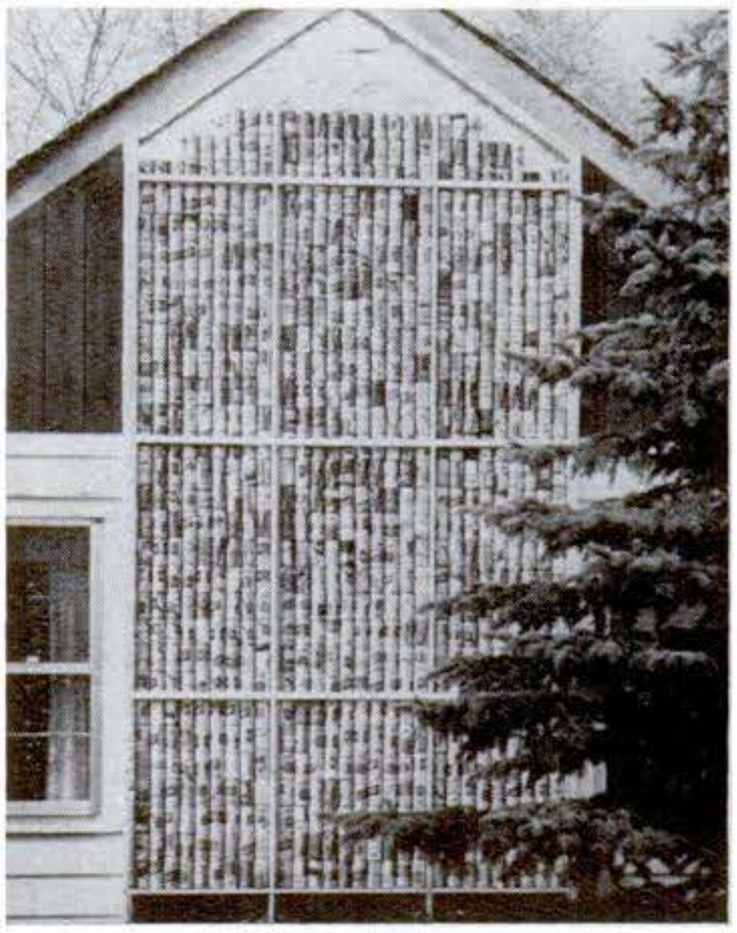
Even armchair enthusiasts of the sport shouldn't find the tabletop version of soccer—or foosball, pictured below—too strenuous. In fact, you'll get more exercise by building it from a kit you buy for $16.95. Included: instructions and drawings; wood molding you cut into 22 "players"; nylon bushings; rubber bumpers; plastic goalie-rod bushings; steel goalie-rod stops; and three foosballs. You supply: lumber for sides and legs; plywood base; steel rods; glass playing surface; and miscellaneous hardware. Kicks Foosball Kits (Box 1061, Oak Park, Ill. 60304) estimates that the additional materials will cost between $30 and $45.

Mail-order appraisal

How much is your home worth? What would it cost to replace it? What about the dream home you've been planning? Fill in the details on a House-T-Mater questionnaire (construction, size, special features, whether a contractor or a developer will build it, etc.) and you'll get a computerized estimate in the mail. Com-Tec, the company that offers the service, says that accuracy to within 10 percent is ensured. That's because construction costs for all postal zip-code areas in the U.S. are computed and updated every three months. Cost of the estimate is $10. For a questionnaire, write Com-Tec, Computer Technology of Illinois, Box 3582, Peoria, Ill. 61614.

How many cans of beer on the wall?

At first glance, you might think that an obsessive collector of beer cans has decided to go public with his collection. Actually, Bruce Hilde, a construction worker from Moorhead, Minn., fastened discarded cans to the south side of his



home to serve as a low-cost solar collector. Hilde punched holes in the top and bottom of each can, and stacked them in vertical columns in a lumber framework; after taking the photo, he painted the cans black, then double-glazed the assembly. The sun heats the air in the cans, which rises and flows into the attic. From there, a fan circulates it through the house. [For a variation, see PS, May '76, p. 102.]

Hilde says he saves $150 a year on heating bills. That's not all. He also won $1000 in a contest sponsored by the University of Minnesota and the Minnesota Society of Architects. The contest, held early this year, was designed (says coordinator Huldah Curl) to "get everyone thinking about new ways to make do with what is available in natural resources."

What's in the wind?

The American Wind Energy Assn., via a newsletter, a quarterly journal, conferences, and other publications, aims to keep its membership up to date on the world of wind power. An individual membership, which includes a subscription to the quarterly *Wind Power Digest,* costs a tax-deductible $25. If you're a corporation, it's $100. For more information write AWEA, 1919 14th St., Boulder, Colo. 80302.

And under the sun?

For national and regional news on solar energy, $8 for a year's subscription to *Solar Utilization News* would be money well spent. Write the Alternate Energy Institute, Box 3100, Estes Park, Colo. 80517. PS

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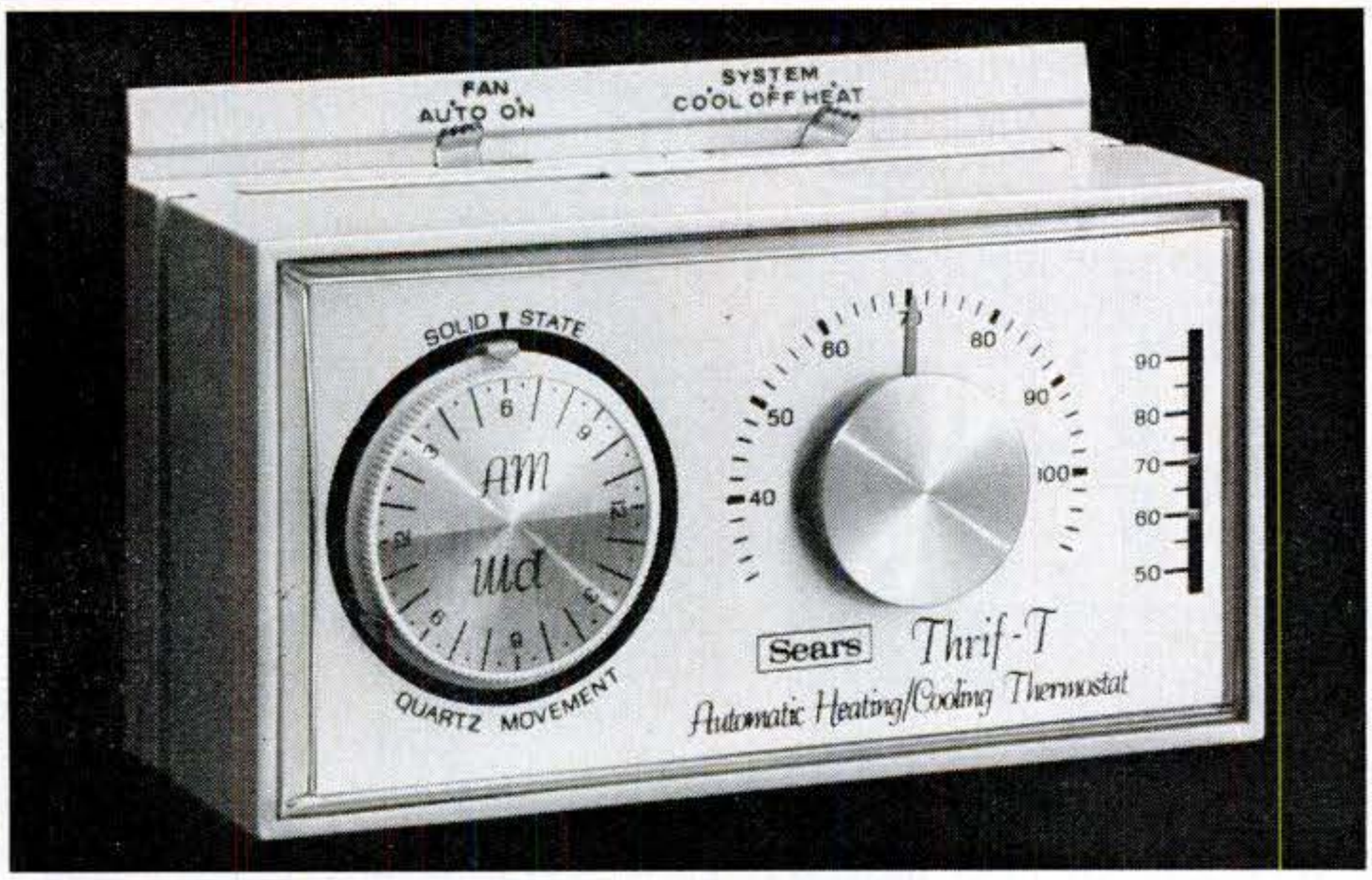
Sears Thrif-T Thermostat helps you lower your fuel costs automatically!



See for yourself the kind of heating/cooling savings Sears Thrif-T Thermostat can help you achieve by automatically changing the temperature twice a day.

Approximate Percent of Energy Savings

	Heating* (nighttime setback) 5°	10°	Cooling* (daytime setup) 5°
Atlanta	11%	15%	9%
Chicago	7	11	16
Dallas	11	15	8
Los Angeles	12	16	20
Minneapolis	5	9	8
Pittsburgh	7	11	10
St. Louis	8	12	9
Seattle	8	12	9

*Above savings are based on computer study of a one-story home of 900 square feet with four people in the household. Heating savings based on daytime setting of 75° and nighttime setback from 10PM to 6AM. Cooling savings based on 75° nighttime setting and daytime setup period from 5AM to 4PM. Your savings may vary.

The Sears Thrif-T heating/cooling Thermostat is controlled by a 24-hour timer. In winter, it can automatically turn down your heat while you sleep at night, then can turn it back up before you get up. In summer, it can automatically increase the temperature while you're at work then lower it at a preset time before you get home.

You can save on your fuel consumption for heating and cooling no matter whether you use oil, gas or electricity.

Installation is fast and easy when you're replacing an existing thermostat because there's no additional wiring. A screwdriver is all you need. No dangling wires for the timer, either: a special, long-lasting NiCad battery runs the quartz timer and recharges itself.

Buy now and save $15 to $20 off the Sears Thrif-T Thermostat price.

Replaces most existing thermostats.

ON SALE

Heating/Cooling unit

SAVE $20

Reg. $69.99

NOW $49.99

Heating only unit

SAVE $15

Reg. $59.99

NOW $44.99

Sears

Sale starts October 30, ends November 27, 1977.

Thrif-T Thermostat on sale at most larger Sears retail stores in metropolitan Pittsburgh, St. Louis and Atlanta.

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INEXPENSIVE NON—HYDRAULIC SYSTEM
23" splitting stroke in less than 8 seconds (total cycle 11 sec.) Safe, efficient, and economical. Ideal for homeowners, ranchers and farmers. For free information:
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6901 S. Yosemite, Englewood, Colorado 80110

REAL SWITCHBLADE... COMB! (9 INCHES LONG)

This is a **REAL SWITCHBLADE**. The blade is a **COMB!!!** Terrific gift item. Novel and practical. Protects comb in pocket. Fine tooth comb is great for sideburns and mustache too! Satisfaction is guaranteed. Complete with Lock. Only 4.95 + 50¢ Postage. **Two for 10.00 Postpaid.**
S&W KNIFE CO. Box 35246 PS Chicago, Ill. 60635

110 VOLT A.C. GENERATORS
60 cycles, 3000 watts. Wt. 27 pounds, 5"x10" Fan-belt driven from car or pickup. Operates T.V. all power tools. Over 15,000 in service. This is our 27th year. Guaranteed 6 months. $125.00 Postpaid while supply lasts. Our X1200-watt generator needs no battery. Special price—$115.00 Postpaid.
VIRDEN PERMA-BILT
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This ONE Wiring Tool Does The Work Of FIVE

① Long Nose Plier
② Wire Stripper
③ Wire Cutter
④ Bolt Cutter
⑤ Wire Crimper

It strips wire without damaging the conductor. Cuts machine bolts without damaging threads. Cuts wire with a clean, scissors action. Crimps both insulated and non-insulated wire to make permanent, solderless connections. Its lean plier-nose pulls wire, loops wire ends, loosens and tightens small nuts. Blue dipped plastic cushion grips are kind to hands. Tough, durable, precision made to CHANNELLOCK standards. Length 8¼ inches.

The No. 908G WIRE TOOL by CHANNELLOCK. Ask your tool supplier for it. Write for free catalog information. CHANNELLOCK, INC., Meadville, Pa. 16335.

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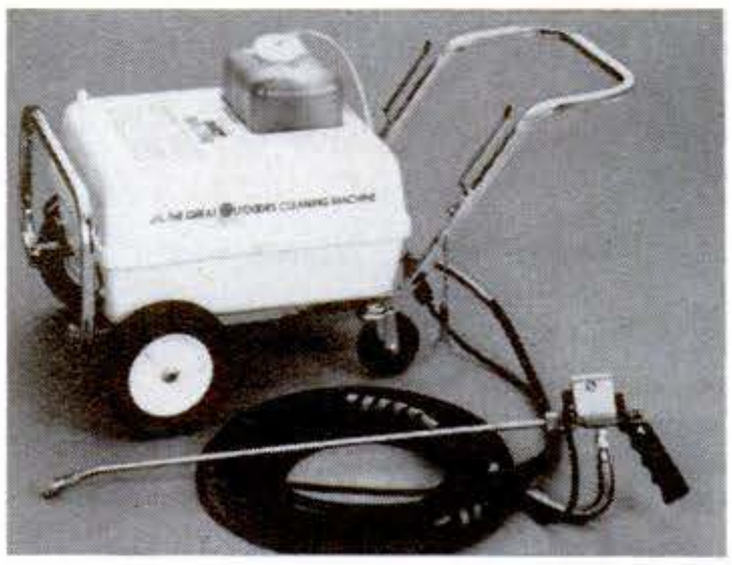

Power washers
speed fall cleanups

Hook up your garden hose to one of these new cleaners, add detergent, and you can attack even the dirtiest garage floor or RV. The cleaners work off 110V house current. Both the Liquid Brush (top) and the Blue Lustre Dirt Buster (center) deliver 1.8 gallons per minute. Liquid Brush produces a 500-psi, fan-shaped spray that'll scour paint blisters off your house, says the maker (Britt-Tech Corp., Box 216, Britt, Ia. 50423). Price: $335. Dirt Buster, made by Earl Grissmer Co. (7950 Castleway Dr., Indianapolis, Ind. 46250) costs $349. Its nozzle adjusts from a 550-psi fan-spray to a single powerful jet.

Hotsy's model 410 (bottom) not only delivers 1.5 gpm at 500 psi—it also heats the jet to a scalding 210° F. A kerosene- or oil-fueled heating coil does the job. It's $795. Hotsy Corp. (6557 S. Emporia St., Englewood, Colo. 80110).—*S. Renner-Smith*

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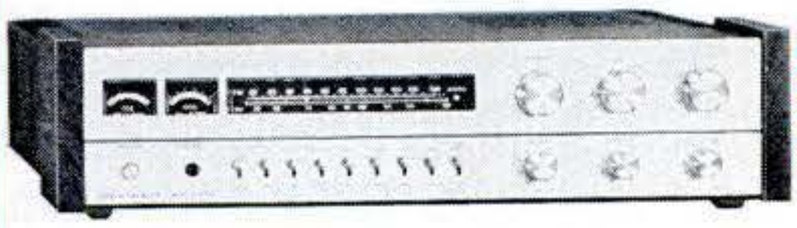
Exciting New Gift-Time Kits from Heath!

GD-1110 Pin Ball Game

The fantastic Bally Fireball® in low-cost easy-to-build kit form by Heath. Never-ending fun and excitement for one to four players. Makes your home a fun entertainment center for the whole family. Only $599.95.



AR-1429 Stereo Hi-Fi Receiver

A low-priced high performer for the audiophile on a budget; 35 watts, minimum RMS, per channel into 8 ohms with less than 0.1% total harmonic distortion from 20-20,000 Hz. All the features of a high priced unit including optional Dolby® FM. Only $319.95.

CS-1048 Cruise Control

Increased fuel economy and less driver fatigue. Just set your desired speed and the CS-1048 does the rest automatically. You'll wonder how you ever did without the CS-1048. For all cars with open-type driveshaft. Only $79.95.

GD-1186 Digital Scale

A digital readout "weighing machine" to show your weight more precisely than scales having ordinary dials. Bright red LED numbers can be read from as far away as ten feet. Solid state circuitry is battery operated for complete safety. All this at the lowest price we've seen yet. Only $99.95.

TO-1860 Heath/Thomas Organ

A microprocessor-based musical instrument that anyone can play like a pro in just a short time. Color coded keys and music make it easy. Automatic rhythms, instrumental voices and more. Nine preassembled circuit boards make it the easiest-to-build organ we've ever offered too! Only $1749.95.

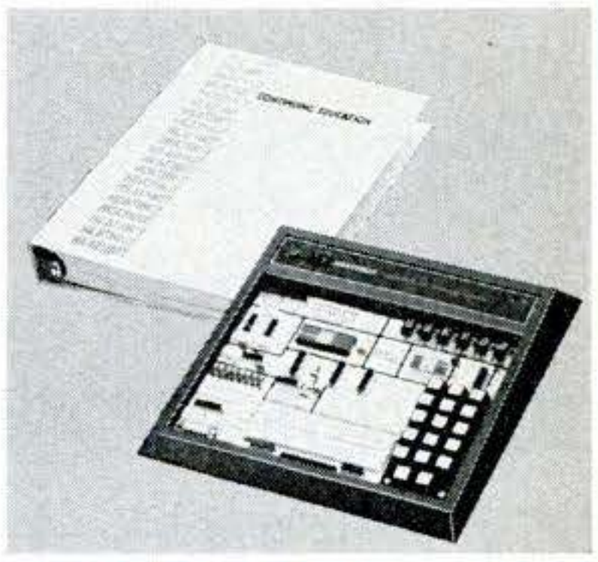
Personal Computers

A complete line of computer products for the hobbyist, home, business, school or just for fun. Designed with a "total system" concept, they're the ones you've been waiting for. The new computer line includes the H8 8-Bit 8080 Digital Computer, the H11 16-Bit LSI-11 Digital Computer, the H9 Video Terminal, the H10 Paper Tape Reader/Punch, and the fabulous LA36 DEC Writer II Keyboard Printer Terminal. And they are priced at values you wouldn't believe possible!

All prices mail-order net F.O.B. Benton Harbor, Michigan.
Prices and specifications subject to change without notice.

Microprocessor Course

EE-3401 tells you everything you need to know about microprocessor operation, interfacing and programming. Do useful hardware and software experiments with the optional ET-3400, the 6800 microprocessor-based trainer. Only $89.95 for the Course, $249.95 for the Course and Trainer.



GC-1107 Digital Alarm Clock

A pleasant addition to your bedroom decor and the perfect way to keep track of the time. Big bright blue digits are easy to read and features like the 24 hour alarm and the snooze button come in very handy. An easy first-time or anytime kit to build and only $27.95.

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Announcing the second annual PS/APA PLYWOOD PRO CONTE

$3000 in cash prizes in four categories including $1000 Grand Prize

Following the great success of this year's contest (winning projects were shown in our August issue), POPULAR SCIENCE, in cooperation with the American Plywood Assn., is again seeking fresh, clever, well-designed projects that take full advantage of the practicality and economy of plywood. And for our new competition, we've broadened the rules: To qualify for the original contest, entries had to be built from a single 4-by-8-ft. sheet; this time, you can use from a half-sheet up to two sheets. Your ingenuity may be rewarded with a cash prize.

● **PRIZES:** A $1000 check will go to one Grand Prize winner selected from all entries received. In addition, $500 checks will go to the top designs in each of four categories, depending on the amount of plywood used. An Honorable Mention Award in each category will consist of a package of how-to books from the *Popular Science* Book Division.

● **HOW TO QUALIFY:** Your project must be constructed from a stated amount of APA-grade-trademarked plywood appropriate for the intended use: from ¼" to ¾" (thicker if required for structural strength); exterior type for outdoor or bathroom projects, interior for indoor. Projects must be carefully designed for efficient layout on the plywood sheet or sheets you select; parts should be scaled, arranged and nested to minimize waste. You may enter your project in any of our four categories, specifying which thickness you chose for your half (4-by-4-ft.) or full (4-by-8-ft.) sheet. Should you choose to enter the 1½- or two-sheet category, you have the option of using two different thicknesses, if structurally justified (for example, a compartmented chest where a full sheet of ⅝" plywood is used for the case and a half-sheet of ¼" plywood for interior dividers and drawer bottoms).

In all categories, aim for minimum waste and minimum use of additional materials; non-plywood purchases must not exceed $75, and plywood should remain the dominant material. We're seeking functional, structurally sound design, but decorative or ingenious projects will also qualify if they represent an efficient use of the sheet or sheets you specify, and if they can be constructed with home-workshop tools.

● **HOW TO ENTER:** Fill out our entry coupon, or list all information the coupon calls for on a separate sheet of paper—including a rough sketch of the APA grade-trademark(s) stamped on the back face or edge of the plywood you chose. Mail this with at least one clear photograph (black-and-white or color print preferred, though color transparency is acceptable), plus a dimensioned diagram of how the project parts were laid out on the sheet or sheets; a crude pencil sketch will suffice as long as it's thoroughly and accurately labeled with critical dimensions. We also need a list of all materials used; grade and thickness of plywood; plus any lumber, hardware, and finishing materials (paint, stain, plastic laminate). Also jot down for us any special construction tips you'd like to pass along to anyone attempting to duplicate your project. If no publishable photo exists, *Popular Science* and APA reserve the right to arrange photography at your convenience (and our expense). Entries must be delivered to the Tacoma Post Office Box by March 1, 1978, and become the property of APA and/or *Popular Science*. Print the category you're entering (HALF, FULL, 1½, TWO) in the lower-left corner of your envelope (only one entry per envelope, please). No entries can be acknowledged, and none will be returned unless accompanied by a written request and a self-addressed envelope with sufficient postage.

● **JUDGING** (by PS Reader Activities Editor Al Lees and representatives of APA) will be for the most efficient and appropriate use of the sheet or sheets you chose. PS will publish dimensioned plans of those prizewinning projects we feel our readers might want to make. Plans for all nine will be available from APA after Sept. 1, 1978.

All prizewinners will be notified by April 15. Winning entries will be in the August 1978 *Popular Science*. PS

ENTRY COUPON (Clip and attach to your plans sketch)

Mail entry to:
POPULAR SCIENCE CONTEST
Box 2277, Tacoma, Wash. 98401

To qualify, entry must reach Tacoma address by March 1, 1978

YOUR NAME (print or type) _____

STREET ADDRESS _____

CITY _____ STATE _____ ZIP _____

Copy the plywood-grade stamp here

Description of project _____

Which category are you entering? ☐ HALF SHEET ☐ FULL SHEET ☐ 1½ SHEET ☐ TWO SHEET

What thickness(es) plywood? ☐ ¼" ☐ ⅜" ☐ ½" ☐ ⅝" ☐ ¾"

If other, check here ☐ and specify _____

My signature certifies that this project is of my own design.

Sign here _____

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And, as you probably know, Nova comes with one heck of a reputation.

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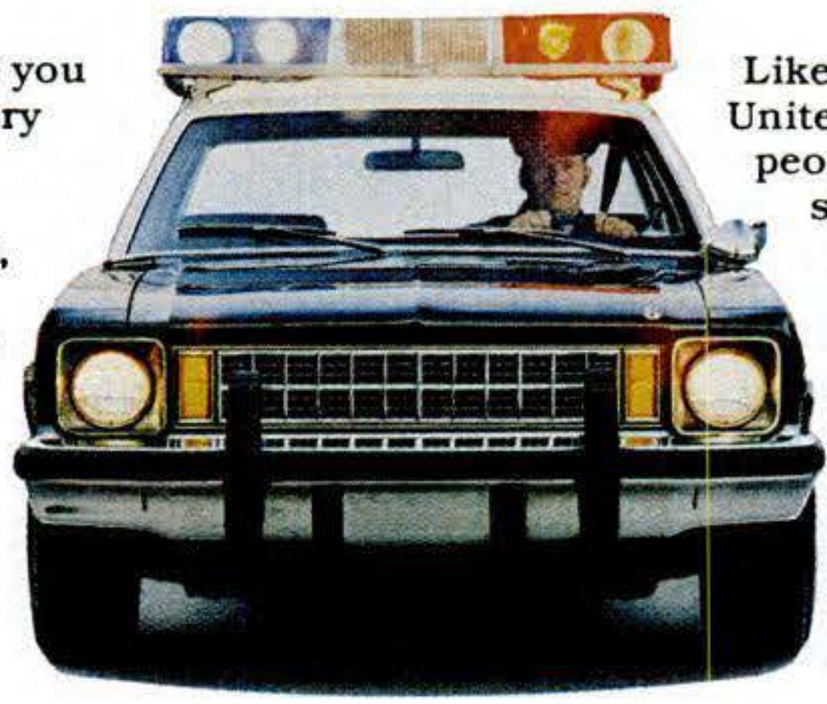

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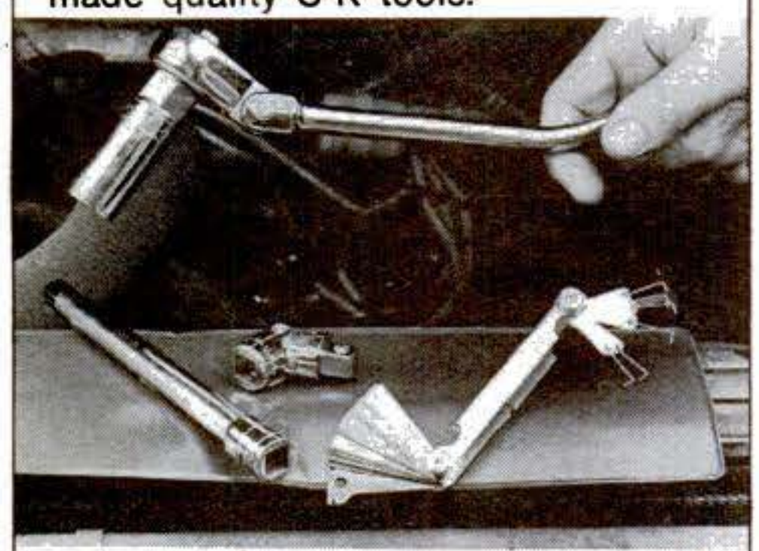

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5 pc. Combination Wrench Set. No. 1705-77. Takes on jobs from motorcycles to power mowers. Total value if purchased separately $18.28

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*All savings based on piece by piece purchase at suggested user prices.

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AUTO-MAINTENANCE BASICS

19th of a series

Inspecting and repairing your car's brakes

By RAY HILL

A brake inspection every 10,000 miles is very important—you can head off any problems by repairing worn or defective parts. With a service manual you can do the inspection and repair work yourself. Here's how.

First, read the section in the manual on brakes. That'll give you the specifics for your make and model. Use the info in this article as a supplement to the service manual, not as a replacement.

Front disk brakes

Jack up one side of the car (either side) and put a jack stand under the A-frame. Let the jack down until its weight is supported by the jack stand. Remove the wheel.

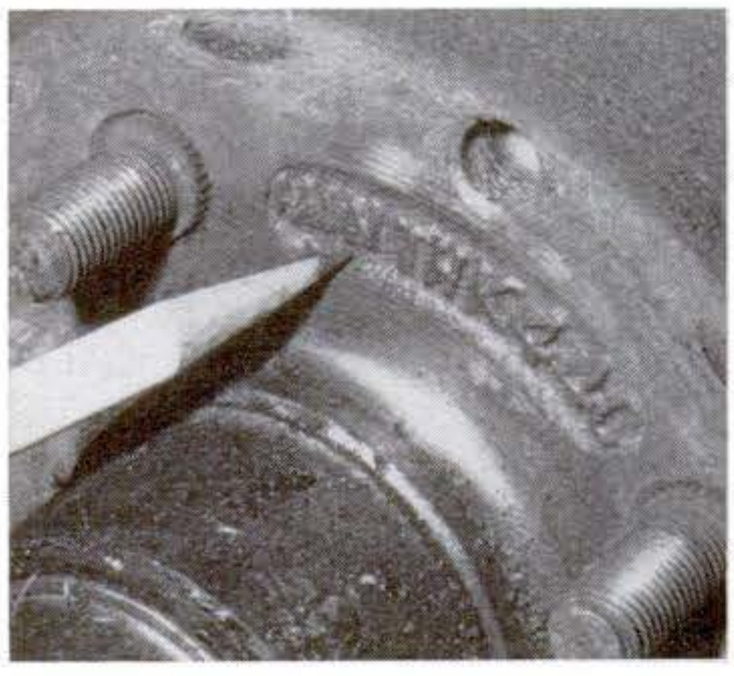
Now inspect the rotor. Look for deep grooves, gouges, and discoloration (black, blue, or super-smooth shiny areas). If none of these are present, the rotor is probably okay.

Look through the inspection window in the caliper assembly. You can see the pads—one on each side of the rotor. The lining of each pad should be at least 3/32 inch. If it's less, or almost this thin, the pads should be replaced. If the rotor and pads look okay, no need to proceed further. Put the wheel back on and check the other side.

However, if there is a question in your mind about the condition of the pad faces (you can't see the pad faces through the inspection window) or if you notice any wetness that might indicate a leaking cylinder, then you'll have to re-

Continued

To support the car use a jack stand under the A-frame when working on the front wheel. Never rely on a bumper jack for support—it may slip.



Somewhere on the rotor will be letters and numbers that indicate the minimum thickness at which the rotor can be used safely after it's been refaced.

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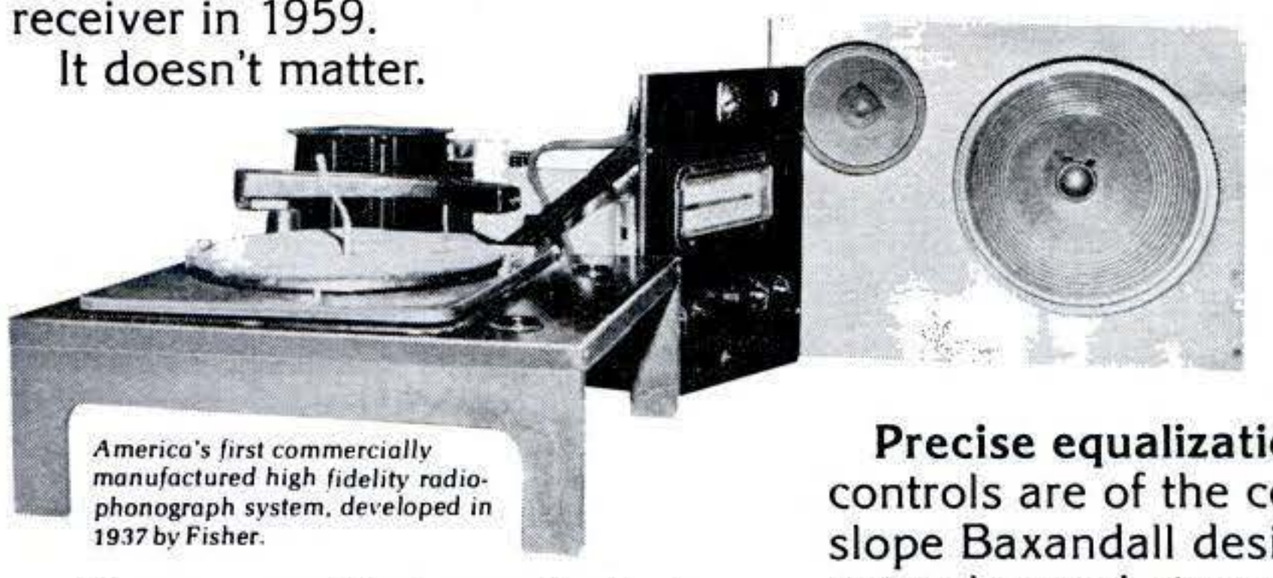
40 YEARS AGO, FISHER WAS AHEAD OF ITS TIME. THE RS1056 PROVES WE STILL ARE.

Maybe you weren't around in 1937 when Avery Fisher was credited with starting high fidelity.

Maybe you don't even remember when Fisher introduced the world's first stereo receiver in 1959.

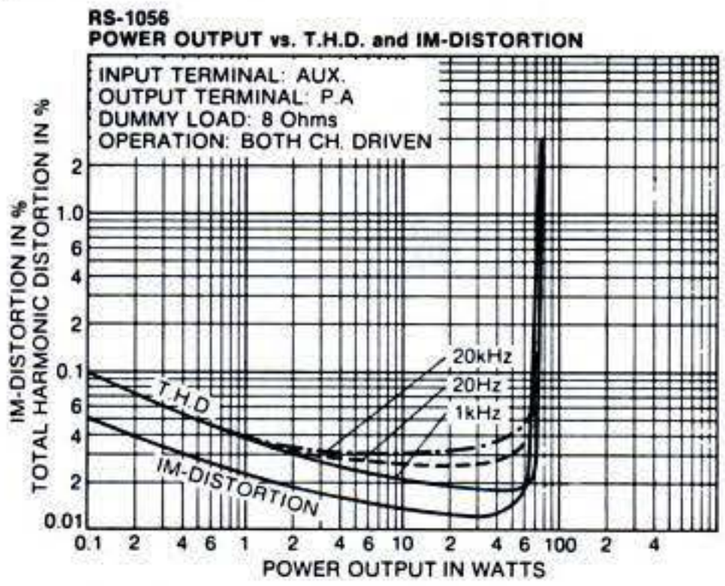
It doesn't matter.



America's first commercially manufactured high fidelity radio-phonograph system, developed in 1937 by Fisher.

All you need to know is that Fisher has shown the way for the rest of the hi-fi industry since the very beginning. 29 audio "firsts" over 40 years.

The new Fisher models are the proud inheritors of that tradition of innovation. And the RS1056 Studio Standard AM/FM Stereo receiver is the embodiment of advanced Fisher technology in the medium-high power class.



Speaking of power: The RS1056 serves up a minimum 68 watts RMS per channel, both channels driven into 8 ohms, 20 to 20,000 Hz, with no more than 0.1% total harmonic distortion. Pure music is all you hear, even at loud levels with less-than-efficient speakers.

Exceptional FM: Fisher's FM front end uses AGC-controlled, dual gate MOSFET transistors that are extremely sensitive, but just about impossible to overload. Add to this the sophisticated linear phase IF filters, and you get extreme 1.7 microvolt sensitivity rivaling the most expensive separate tuners, and FM distortion that's under 0.1% at normal signal levels.

Precise equalization: Tone controls are of the constant slope Baxandall design for natural sound at any setting. In addition, there's a switchable bass turnover frequency—400 Hz for conventional use, and 200 Hz to firm up the really low notes without mid-bass heaviness and "boom."

Controls galore: The RS1056 has more control flexibility than many separate tuner/preamp/power amp combinations. For example: preamp out and power amp in jacks for patching flexibility, biamping, etc. Outputs and switching for up to three pairs of speakers. Dual phono inputs. Two sets of tape inputs, with dubbing. Plus a record out jack right on the front panel for quick, hassle-free temporary hookups. And lots, lots more.

In spite of all these heavyweight features, the RS1056 is still light on the budget... only $450.*

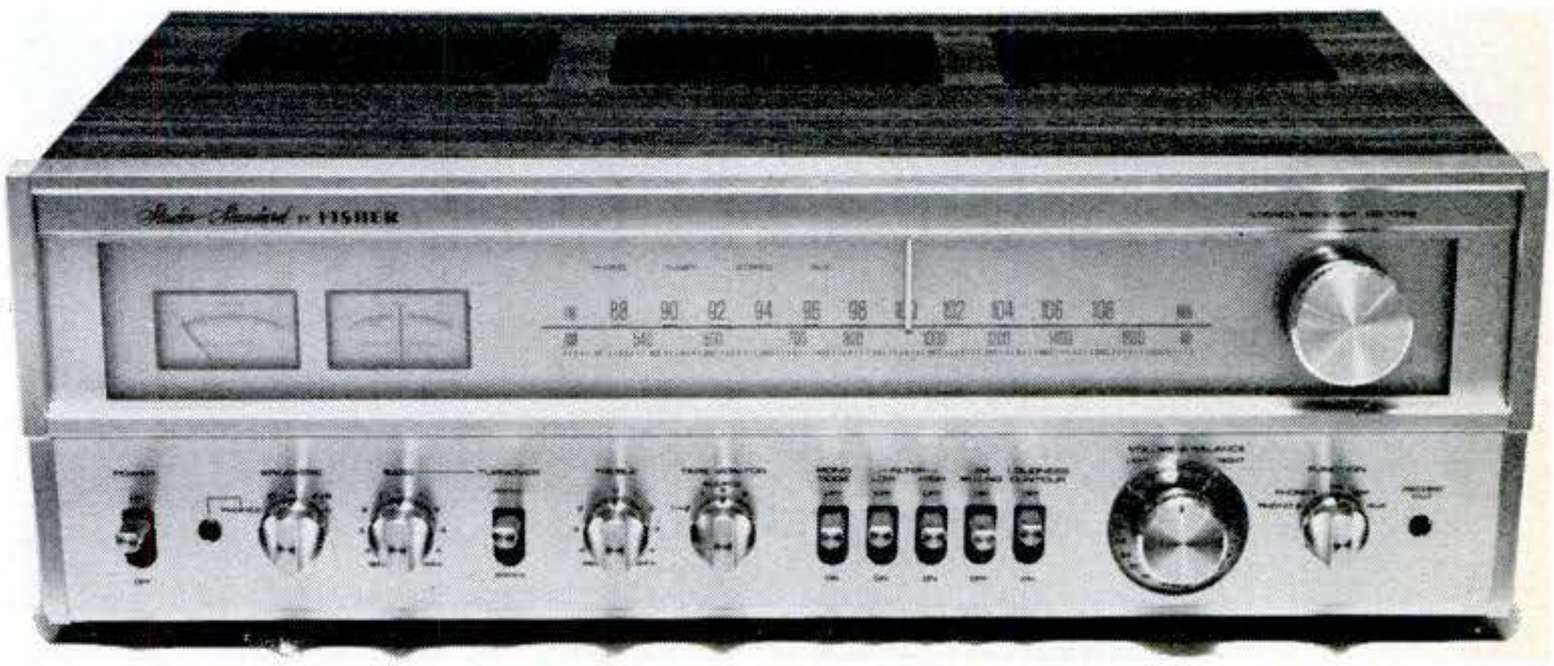
There's a complete line of Fisher Studio Standard receivers from 22 to 170 watts per channel. So no matter what power class you're looking for, you have a choice: a Fisher original, or somebody else's imitation.

So what's it going to be?

Fisher products are available at selected audio stores and the audio sections of better department stores.

Continuous RMS sine wave power per channel within stated bandwidth at no more than stated distortion and with an 8-ohm load	68 watts
Power Bandwidth	20 Hz-20kHz
Total Harmonic Distortion at rated power	0.1%
Total Intermodulation Distortion at rated power	0.1%
FM Usable Sensitivity	1.7μV/9.8 dBf
FM Signal-to-Noise Ratio	75 dB
Dimensions (WxDxH)	20¾"x14¼"x7"
Weight	31.3 lbs.

*Mfg. suggested retail price. Actual price is determined by dealer.



FISHER

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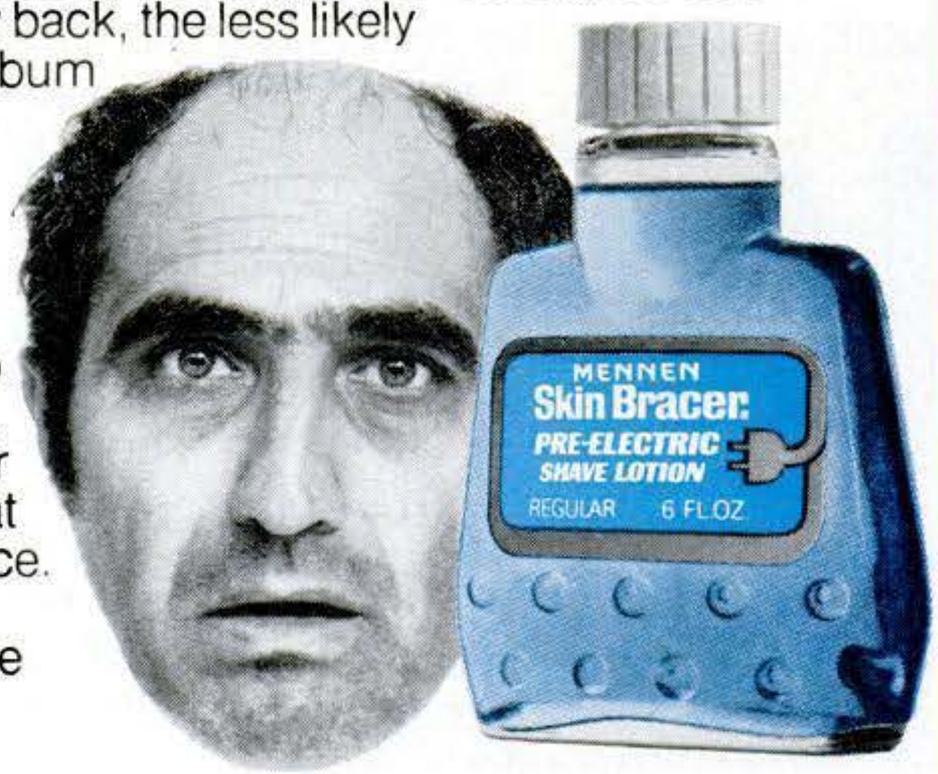
What every stubble bum should know.

The closer you cut your stubble, the longer it takes to grow back. The longer it takes to grow back, the less likely you will look like a stubble bum before you have to shave again. Which brings us to Mennen Skin Bracer® Pre-Electric Shave Lotion. It tightens your face, conditions your stubble so you can shave extra close. It even helps lubricate your razor head, and it's got that clean Skin Bracer fragrance. Congratulations. You are soon to join the ranks of the ex-stubble bum.



move the caliper assembly and check further. If the pads are worn too thin, or the rotor is discolored or scored, you'll also have to remove the caliper assembly.

Caliper removel is not difficult. Just follow the instructions in your manual. Most calipers are held in place by two pins or bolts. When these are removed you can lift the caliper off the rotor.

Before removing the pins or bolts, however, take a screwdriver (see photo) and pry the disk pads apart ⅛ inch or so. Just stick the tip of the screwdriver between one of the pads and the rotor, and pry. This prevents the pads from hanging on the rotor as you pull the caliper off.

After removing the caliper, don't let it hang by its flexible brake hose when you're not holding it. That can damage the hose. Lay the caliper on top of the upper control arm. If it won't stay there, wire it in place. (If you disconnect the brake hose, of course, you won't have to worry about this.

If the rotor face is badly scored or discolored, it probably needs refacing. Many auto-parts supply houses, as well as some garages, are equipped to reface brake rotors. If you're in doubt, have it checked.

After a rotor has been refaced, clean the inside of the rotor hub (where the bearings are) with a clean rag, making sure all metal shavings are removed. Otherwise you may score the bearings when you replace them. Clean, inspect, and repack the bearings [see Auto-Maintenance Basics, PS, Feb.]. Then replace the rotor.

Now let's go to the caliper. If only the pads need replacing, just slip the old pads out and the new ones in. Some pads just slide out; others are clipped in. Eyeball yours to see how they are removed.

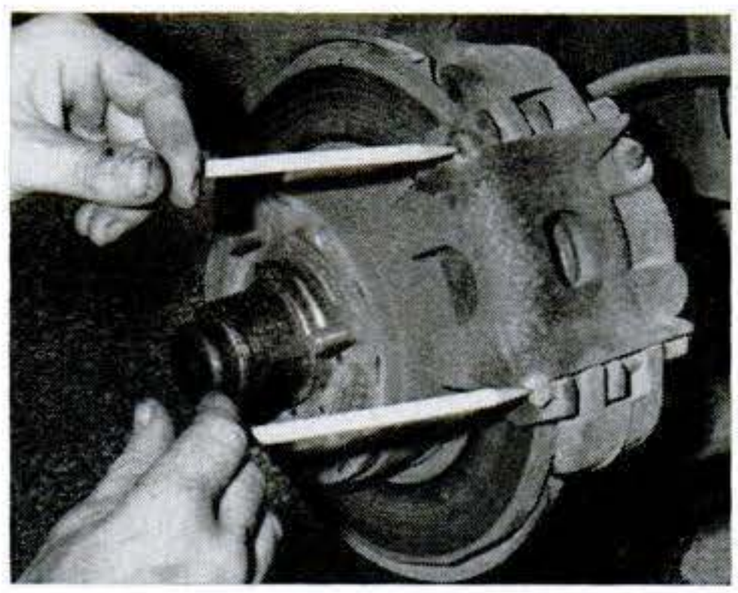
On some cars the inner and outer pads are the same; on others they're different. Be sure you replace them in their proper position.

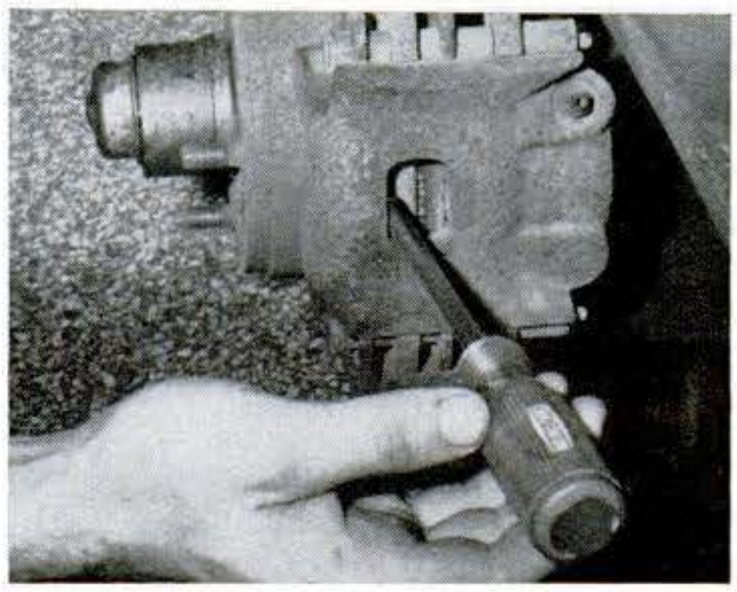
Take special care if you're planning to reuse the pads—especially if they're identically shaped. Mark them so that you'll replace them in their former positions. Pads don't wear evenly, and braking will be reduced if pads are switched.

Rebuilding the caliper

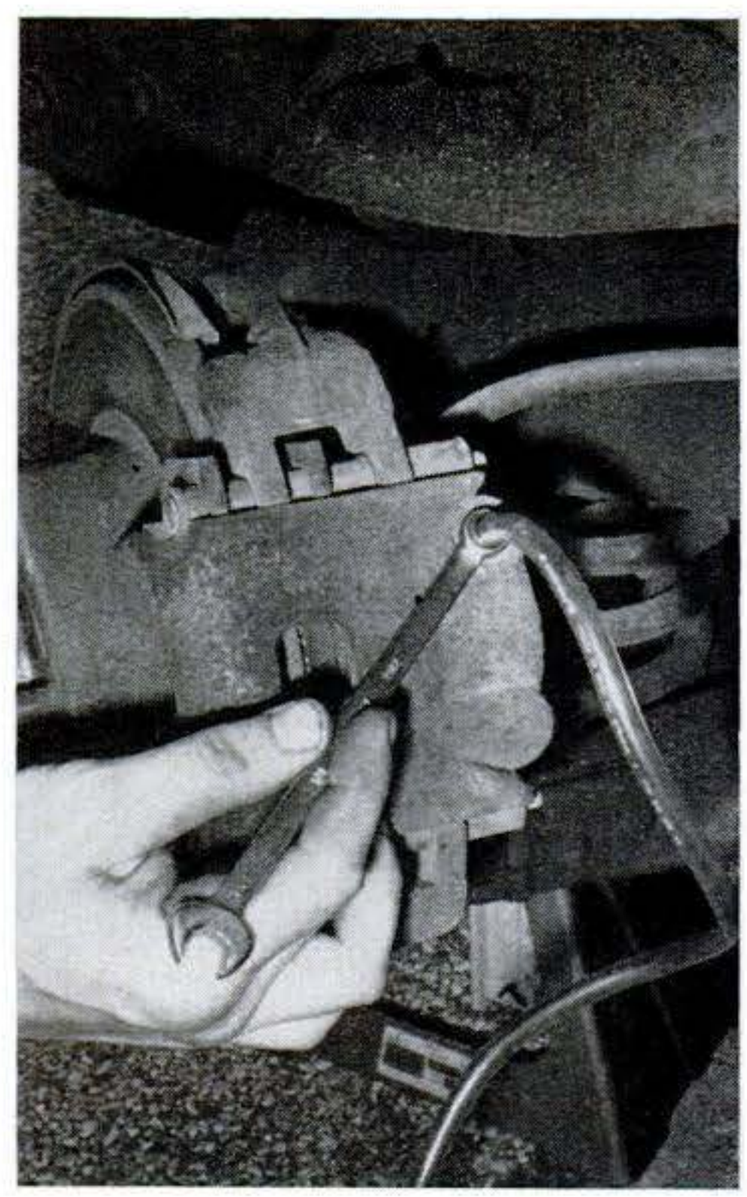
The caliper should be rebuilt every second brake job—even if nothing appears to be wrong. The caliper should always be rebuilt if it's leaking or sticking.

Next step after removing the





Pry disk pads apart by using screwdriver through inspection window (top photo). Two pencils (bottom photo) show where mounting pins are located.



When bleeding disk brakes, place a clear plastic hose over the bleeder screw to direct brake fluid to a container. For drum brakes, procedure is similar.

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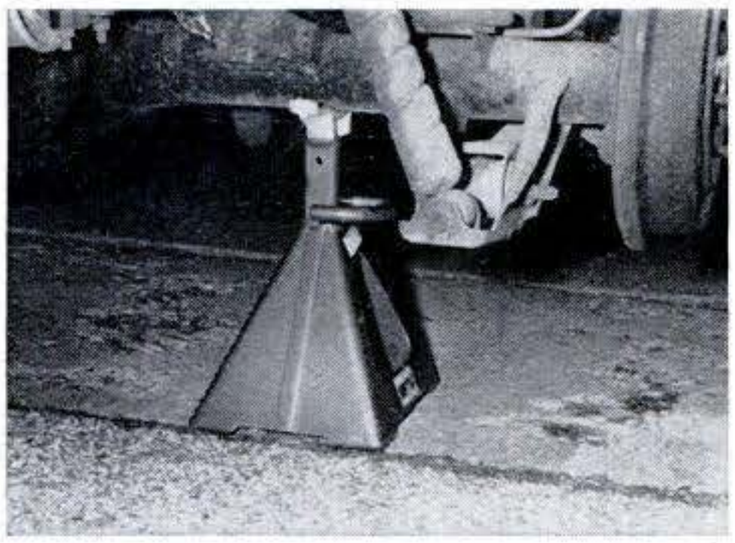
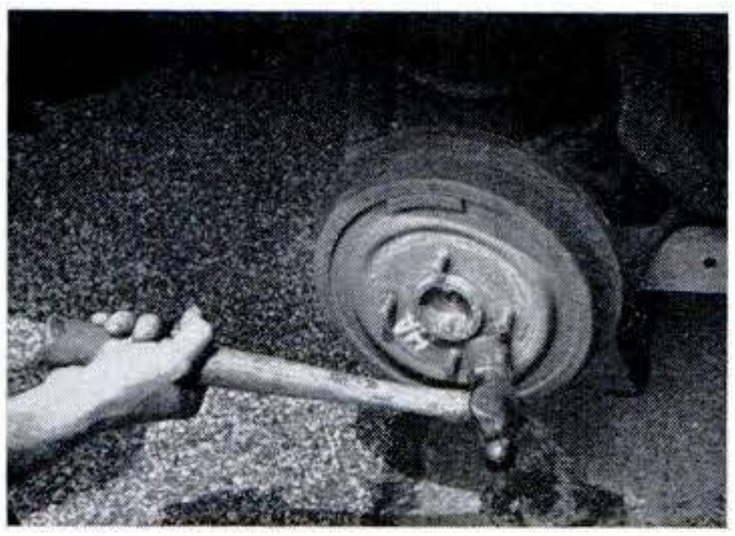
pads is to remove the piston. The easiest way is to have someone pump the brake pedal until the piston is forced out enough so that you can grasp it with your fingers and pull it out the rest of the way.

When you're pumping out the piston, both rear brake drums should be on. Otherwise the hydraulic pressure will pop the pistons out of the rear wheel cylinders. Also, only one front caliper should be off—the one you're working on.

Once the piston is out, only two pieces are left inside the cylinder —a neoprene O-ring seal (which seals between the inside of the housing and the piston) and a dust boot (which keeps dust from getting inside the piston). To remove the seal and dust boot use a small pointed wooden or plastic stick. Don't use a screwdriver or other metal tool to do this—you may scratch the piston bore or burr the edges of the seal groove.



Jack stand is placed under rear-axle housing when the rear brake is worked on. Be sure the jack stand is rated to support your car's weight.



To free stuck drum for removal, hit drum where it fits around the axle. Be careful not to strike wheel studs—you could damage their threads.

Once drum is broken loose, it's just a matter of pulling it off the brake shoes. Apply pulling pressure evenly at both top and bottom of drum.

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AFTER SHAVE & SKIN CONDITIONER

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relieves dryness, relaxes skin
also helps replace washed-out skin oils

SOOTHES
chapped skin too-
on your face, on your hands!

PROTECTS
against sun, wind, weather

THE MENNEN COMPANY

Next step is to hone the cylinder bore. Mount a disk-brake cylinder hone in an electric drill. Squirt a little brake fluid in the cylinder walls to lubricate the hone (also some fluid on the hone stones) and hone the cylinder for 30 to 40 seconds. If you're using a variable-speed drill, pull the trigger only enough for low rpm. If you're using a single-speed drill, click the trigger on and off repeatedly to keep rpm low. You don't want to remove a lot of metal, just clean the cylinder so it will seal well with the new piston.

After honing the cylinder, pour some brake fluid down in the cylinder, slosh it around so that it rinses out the cylinder, then pour it out. Wipe the cylinder with a clean, lint-free cloth. Repeat this procedure until the cylinder is *absolutely clean.*

Your next step is to install the rebuilding kit. This contains a new seal and dust boot and is available at auto-parts supply stores or the parts department of your car dealer. Follow all instructions.

First install the new seal—with clean fingers. You don't want to get any dirt in there. Lubricate the seal liberally with brake fluid before installing.

Now install the dust boot. Some boots just clip into a groove, others must be hammered into place with a special driver. If yours is the type that must be hammered in and you don't have the special driver, you can use a plastic hammer—if you're careful not to hit the dust boot hard enough to bend or misshape it.

Next, install the piston. Use a new piston, for safety's sake—even if the other one looks okay. Holding the dust boot back with your fingers, lubricate the outside of the piston and the inside of the cylinder with brake fluid. Then insert the piston. Once the piston is started, use a C-clamp to force the piston completely into place (making sure that the dust boot is seated properly around the edge of the new piston). Make sure the C-clamp is centered so the piston doesn't cock and jam as you tighten the C-clamp.

Press the piston in until it bot-

Continued

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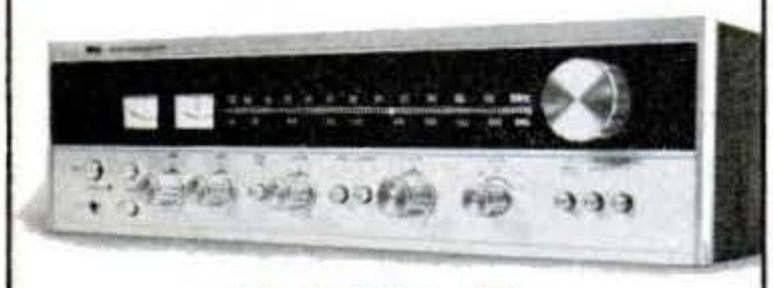

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toms. Then, if you've disconnected the caliper from the brake line, reattach it to the line. Usually the line has a little copper gasket that goes between the line and the caliper. Make sure this gasket is in place. Otherwise the line will leak, even though you have it tightened.

Install the brake pads, slide the caliper over the rotor, and bolt it up according to the instructions in your service manual. Repeat this procedure on the other wheel, then bleed the brakes in accordance with the shop-manual instructions.

Rear drum brakes

Support one side of the car with a jack stand under the car-axle housing. Remove the rear wheel and make sure the parking brake is off. Before removing the brake drum, check to see if there are any retainer clips on the wheel studs. If so, remove and discard them. They don't need to be reinstalled.

Now, grasp the brake drum with your hands—one hand should be directly opposite the other—and try to pull the drum off. No luck? Try to rock the drum vigorously back and forth with your hands, then pull. If it still doesn't come off, take a hammer and hit the drum where it fits around the axle. Keep striking it until it breaks free, then pull it off.

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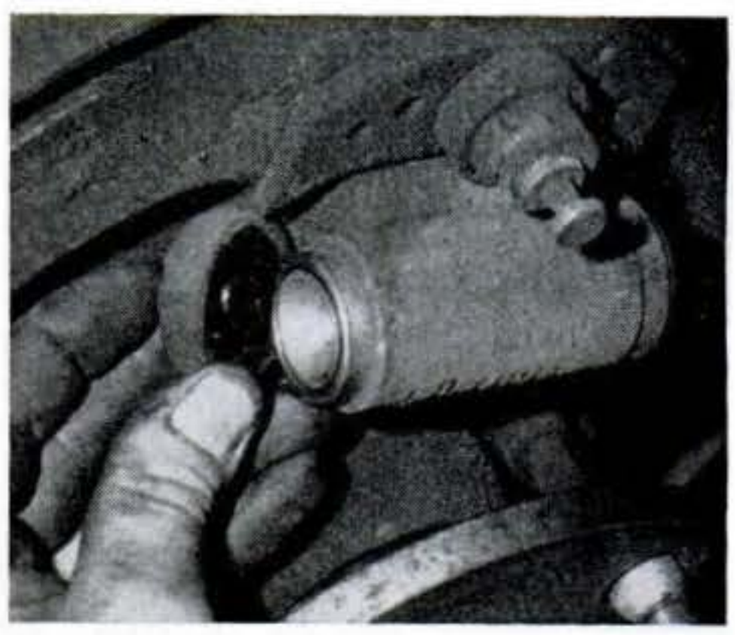
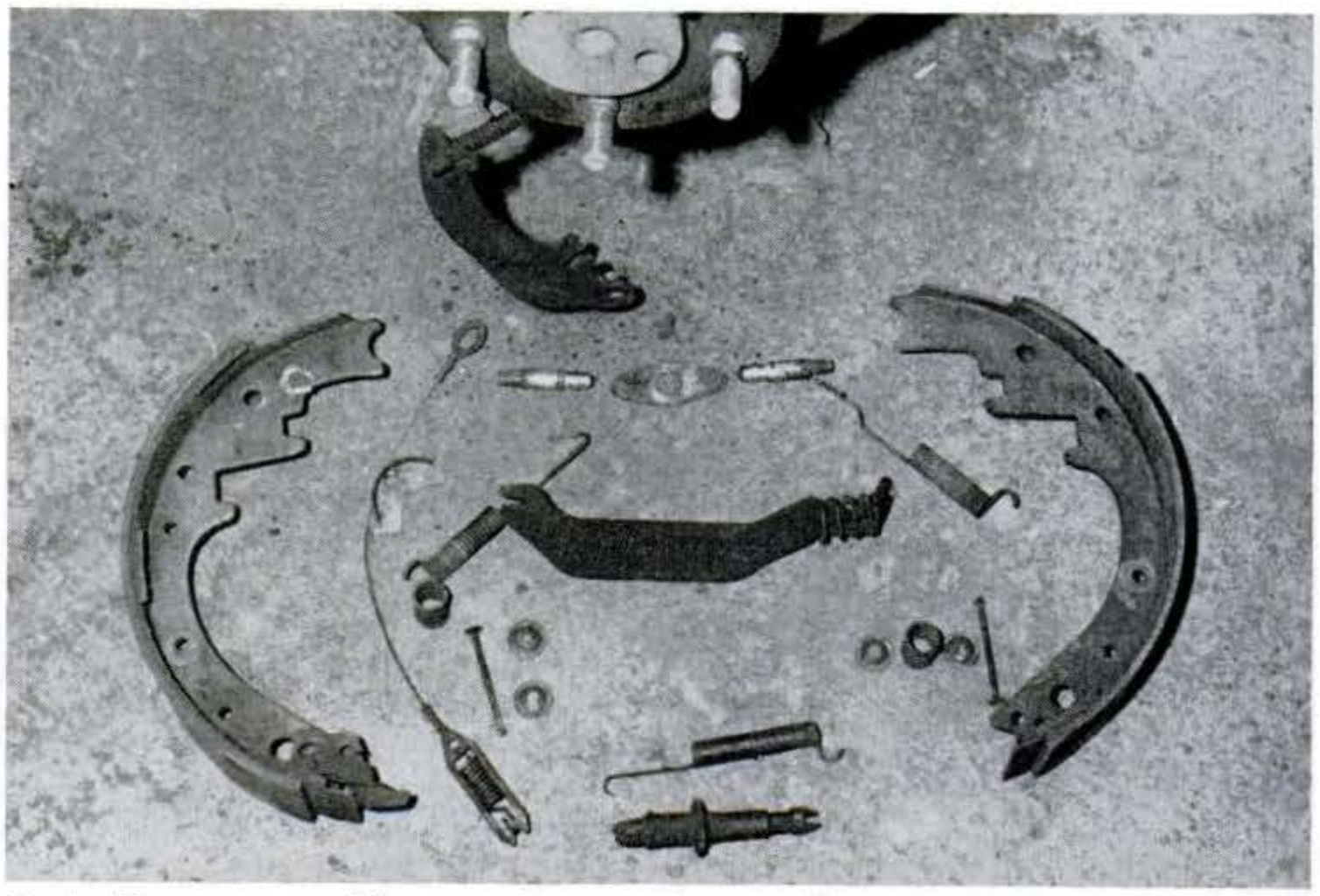


Dust boot is being removed from one end of rear wheel cylinder. After push-rods and dust boots are removed, cylinder's innards are pushed out.

As brake disassembly proceeds (left) remember how pieces come apart, to ease reassembly. Here emergency-brake cable is being disconnected.



To facilitate reassembly even more, as you remove each part, lay it on the floor or workbench in its relative assembled position.

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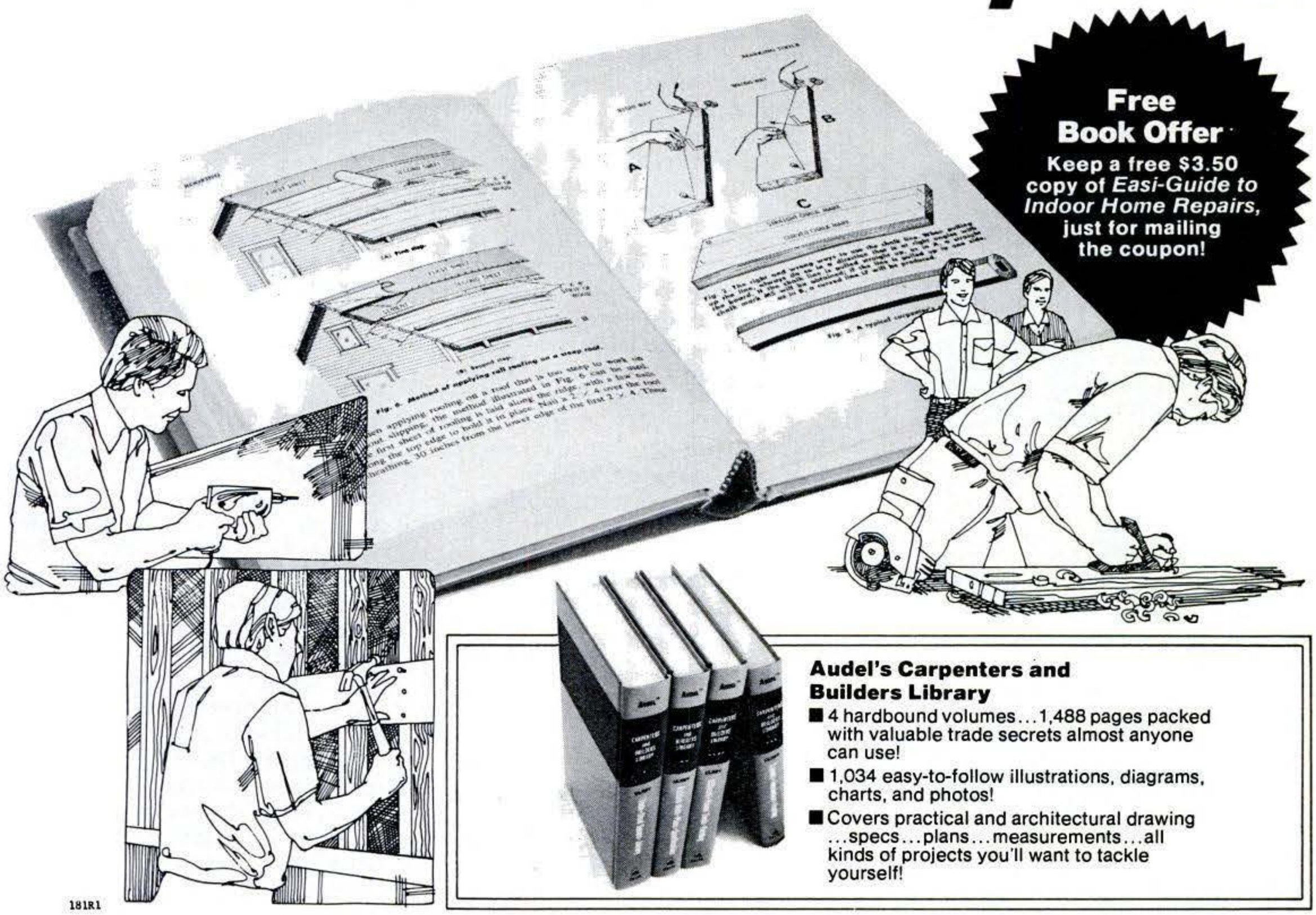

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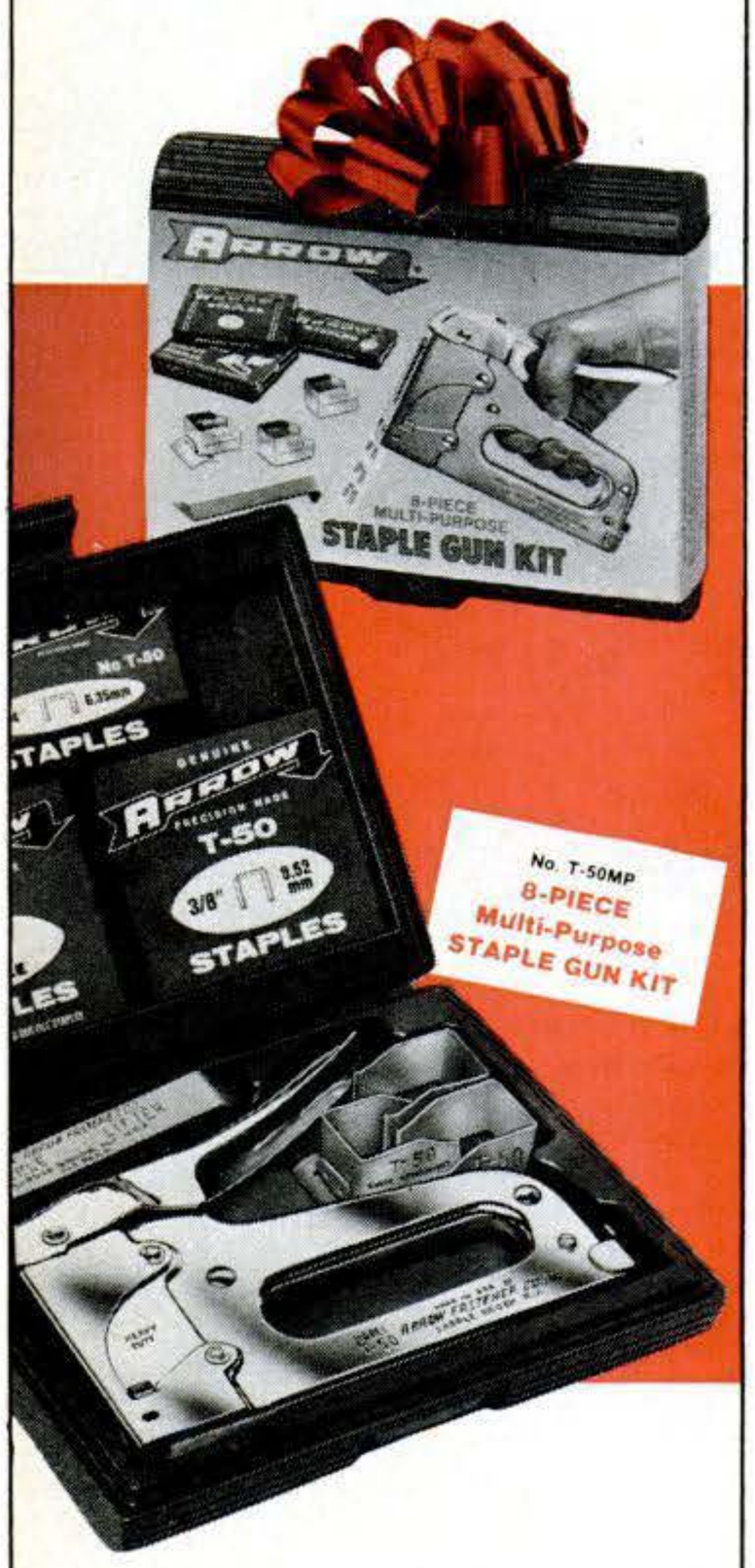

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Be careful not to hit the studs with the hammer—you may damage the threads. In extreme cases, heat may have to be applied to the drum around the axle to make it expand and break loose.

Sometimes, even though the drum is loose, you can't pull it all the way off. This may be caused by a little ridge that has built up around the outer edge of the inside of the drum and won't let the drum slip over the brake shoes. In this case the brakes will have to be "unadjusted" according to shop-manual instructions.

Basically this consists of inserting a narrow awl or screwdriver in a slot in the backing plate, pushing the self-adjusting lever away from the starwheel (brake adjusting wheel) and turning the starwheel with a thin screwdriver or brake adjusting tool. This allows the brake shoes to be pulled closer together by the brake return springs, so you can remove the drum.

With the drum off, examine the two brake shoes. Each should have at least 3/32 inch of lining on it. If not, replace the shoes.

Check the drum in the area where the brake shoes contact it. No ridges, grooves, or gouges should exist here. If they do, the drum should be refaced.

Now, clean the dust from the brakes. Use compressed air if you have it. If not, use a vacuum cleaner. Keep your nose and mouth covered while doing this, since asbestos dust can damage the lungs.

Following service-manual instructions, remove the brake return springs and other side springs and clips that may hold the brake shoes in place.

Although it is possible to remove these springs and replace them with a screwdriver, it is very difficult, and will almost surely result in skinned knuckles or worse. A brake-spring removal tool is the only way to go here. Some are combination devices that will remove both return springs and side springs; others are single units made for one—but not both—type of springs. They're inexpensive and definitely worth the investment.

After the brake shoes are off, examine the wheel cylinder. If it's wet on the outside, rebuild it. If this is your second brake job, rebuild it even if it's not leaking. If this is your first brake job, or if the wheel cylinder was rebuilt on the last brake job, just peel back very slightly the cover of the dust boot on each end of the cylinder. If it's not wet underneath the cover, leave it alone. If it's wet, rebuild the cylinder. And if you rebuild one wheel cylinder, rebuild the other one.

To rebuild, first pull the pushrod out of each end of the cylinder. Then remove the dust boot from each end. Now, with your finger, reach into the cylinder (from either end) and push. Out the other end will come a spring, two pistons, and two cups.

Next, hone the cylinder with a wheel-cylinder hone. Lubricate the hone and cylinder walls with brake fluid, insert the hone, and at low rpm run the hone back and forth through the cylinder for about 30 seconds. Flush the wheel cylinder with brake fluid.

Purchase a wheel-cylinder rebuilding kit, which consists of a new spring, two new rubber cups, new pistons, and two new dust boots. Lubricate the wheel cylinder with brake fluid, then lubricate a piston with brake fluid and push it in. Lubricate a cup and push it in, then put in the spring. Now, lubricate the other cup, push it in, lubricate the remaining piston and push it in. Put the new dust boots on, then push the rods back in through the dust boots.

Reassemble the brake shoes in the order you removed them. To make assembling easier, put each part on the floor or workbench in its proper relative position as you disassemble the unit. That way you are less likely to forget where each part goes.

After the brake shoes are installed, replace the drum. Now stick a thin screwdriver or brake-adjusting tool through the slot in the backing plate and turn the adjusting wheel until the brake shoes just barely drag against the brake drum as you turn it. The self-adjusters will finish adjusting the brakes after you have put the wheels back on and drive the car. The self-adjusters work whenever you back up and apply the brakes.

Repeat the procedure on the other rear wheel, then bleed the brakes in accordance with your service-manual instructions. Bleed before you put the wheels back on—it's easier to reach the bleeder screw this way. PS

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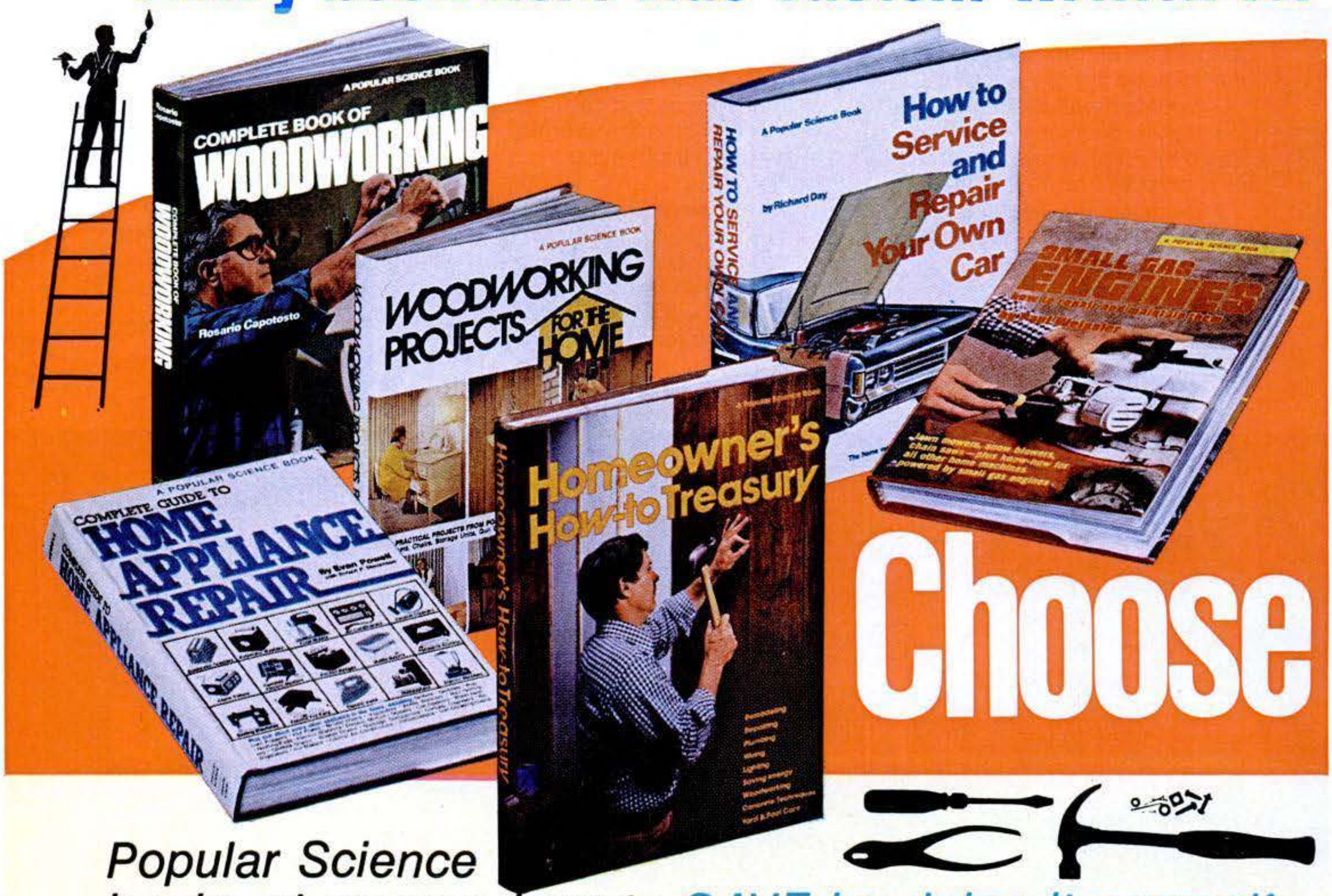

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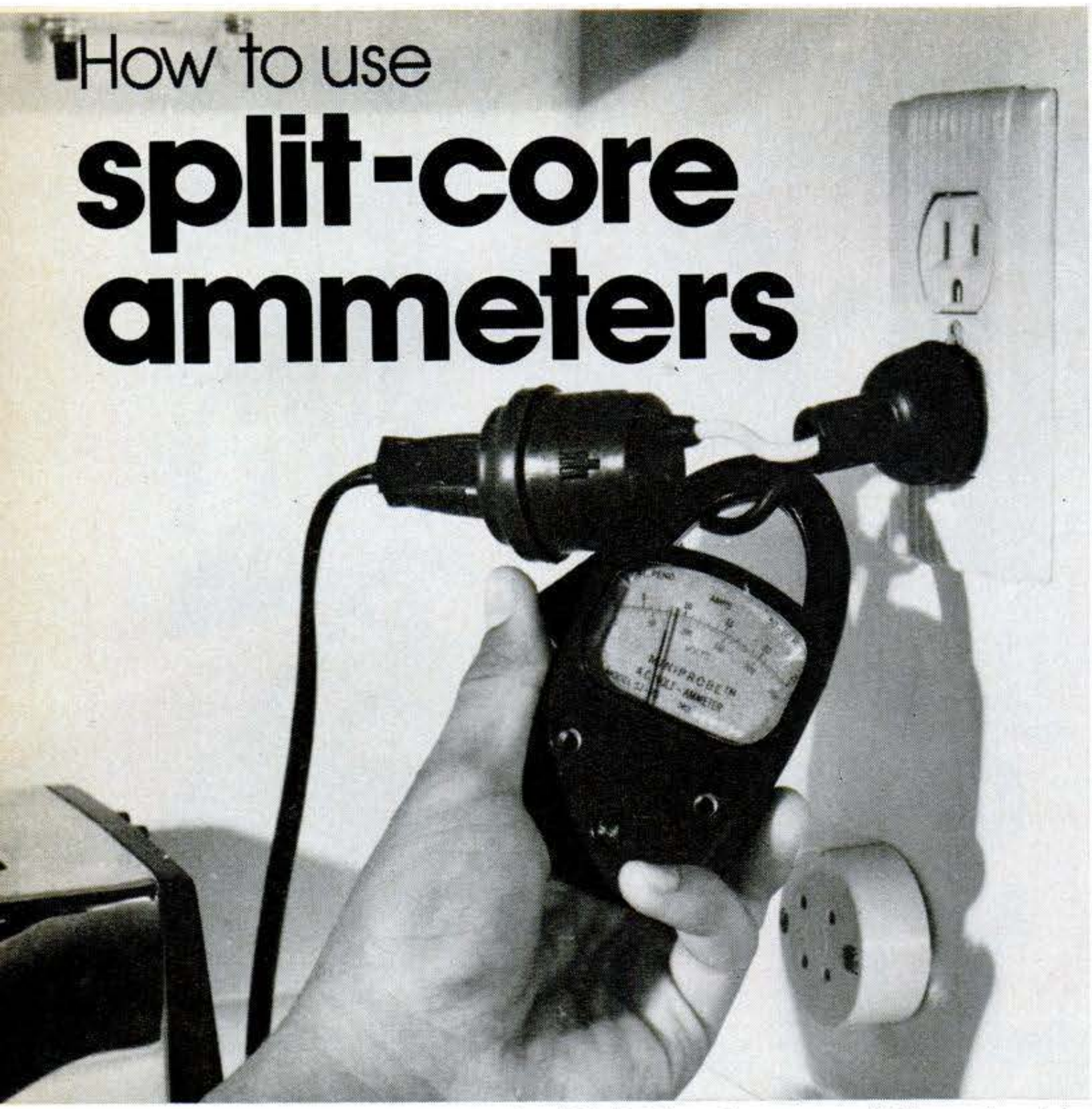
How to use split-core ammeters

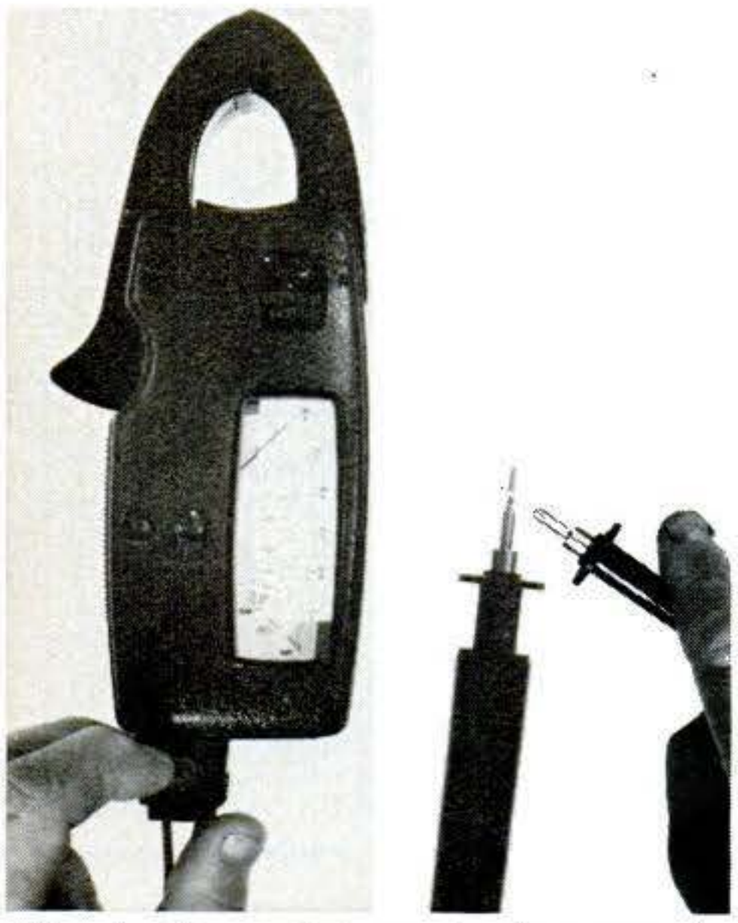


Meters like this Sperry Miniprobe ($24.50) make tests quickly and safely.

No connections, no live wires—just snap one on to test any home appliance

By EVAN POWELL

I have often expressed my feelings about the value of having a volt-ohm-milliammeter (VOM) around the home (or camper, or car, or wherever you happen to be). Well, split-core testers (also called snap-around or clamp-around) go the VOM one better: They measure volts, ohms, *and* current—and they do it easily.



Plug in the resistance lead set on the professional GE Snapper ($56.65) and it automatically reads the ohms scale.

With a conventional VOM or ammeter, it's necessary to actually open the circuit and connect the ammeter in series with the load being tested—time-consuming and sometimes nearly impossible. A split-core ammeter, however, uses induction (the same principle used in a transformer) to read current accurately on AC house circuits without wiring it into the circuit or even touching a live terminal.

Simply press the trigger and snap its jaws around one of the appliance's wires; an accurate (within two percent) measurement of the current being consumed can now be read on the meter. Then just compare this to the specs given on the appliance's nameplate to tell if you have a problem.

In any circuit carrying alternating current, the wires are surrounded by a magnetic field. The clamp-around ammeter uses this field as the primary coil of a transformer circuit. When the jaws close around the wire, they become the secondary coil. The voltage induced in the jaws—which is proportional to the current—indicates the current flowing in the circuit. (Since only alternating current causes this effect, the meter won't work on direct-current, battery-powered circuits, such as those in a car or boat.)

Putting a snap-around to work

Remember that it is dangerous and absolutely unnecessary to work with a "hot" electrical circuit when testing home equipment—and this goes even for the pro. Before exposing any electrical terminals for inspection or testing, turn off all power to the equipment. For resistance tests, it stays off. When making current tests, slip the jaws over the conductor; attach the leads to the terminals for voltage tests. Then, while keeping hands off, turn the power on, note the reading, and turn power off again before removing the leads.

Since the jaws of these ammeters have to be placed around only *one* of the conductors in the circuit being tested, there is a problem in testing devices with standard all-in-one two-conductor cord. If you place *both* conductors of a cord between the jaws, the magnetic field surrounding each one cancels the other out and you will get no reading.

You can easily overcome this, however, by making a short test lead (see opening photo) with a male receptacle at one end and a female at the other. To test the total current load of an appliance, remove the appliance cord, plug it into the test lead, and then plug the lead into a wall outlet. You then snap the meter around one of the test lead's wires. An even better way, however, is to use an accessory "energizer," which not only splits the conductors for you but also gives you more accurate readouts of small currents. More about this later.

Appliances using 220 volts are simpler to check, since the conductors are usually separated before reaching the main terminal board, but you should use the outer (live) and not the inner (neutral) wires. Once you have isolated a conductor for your test, depress the trigger on the side of the meter to open the jaws, slip the stationary jaw over the conductor, and release the trigger. Never clamp the conductor *between* the two jaws; they should simply encircle the conductor under test. Also, never support the instrument from a conductor.

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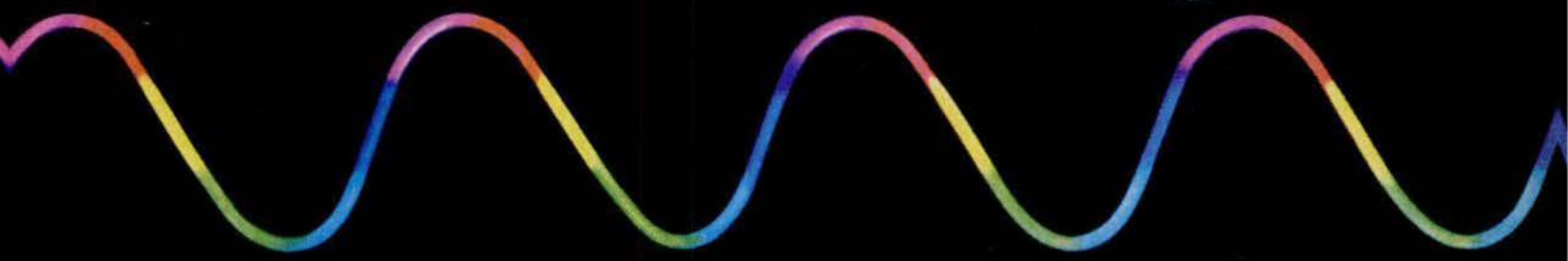

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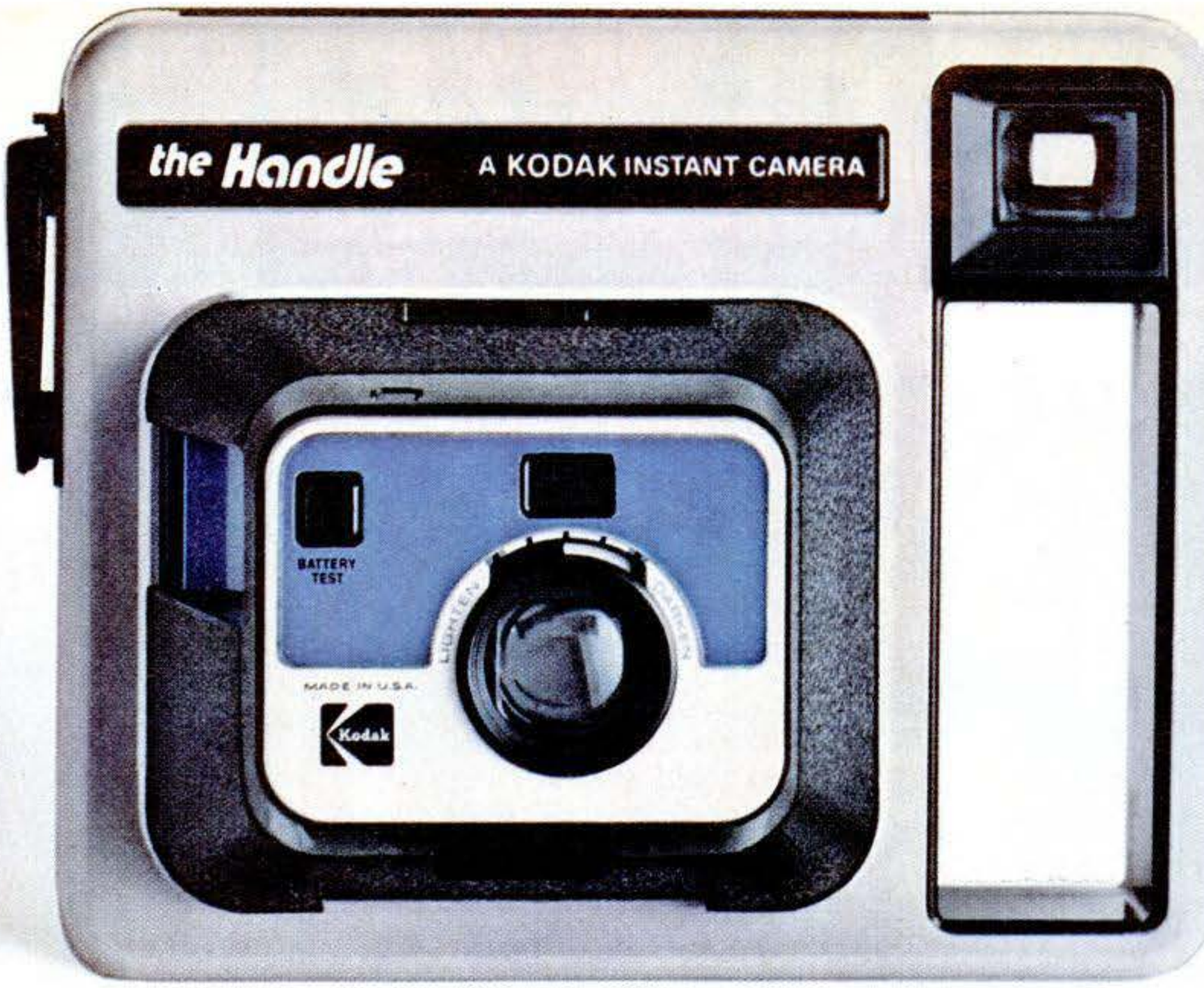

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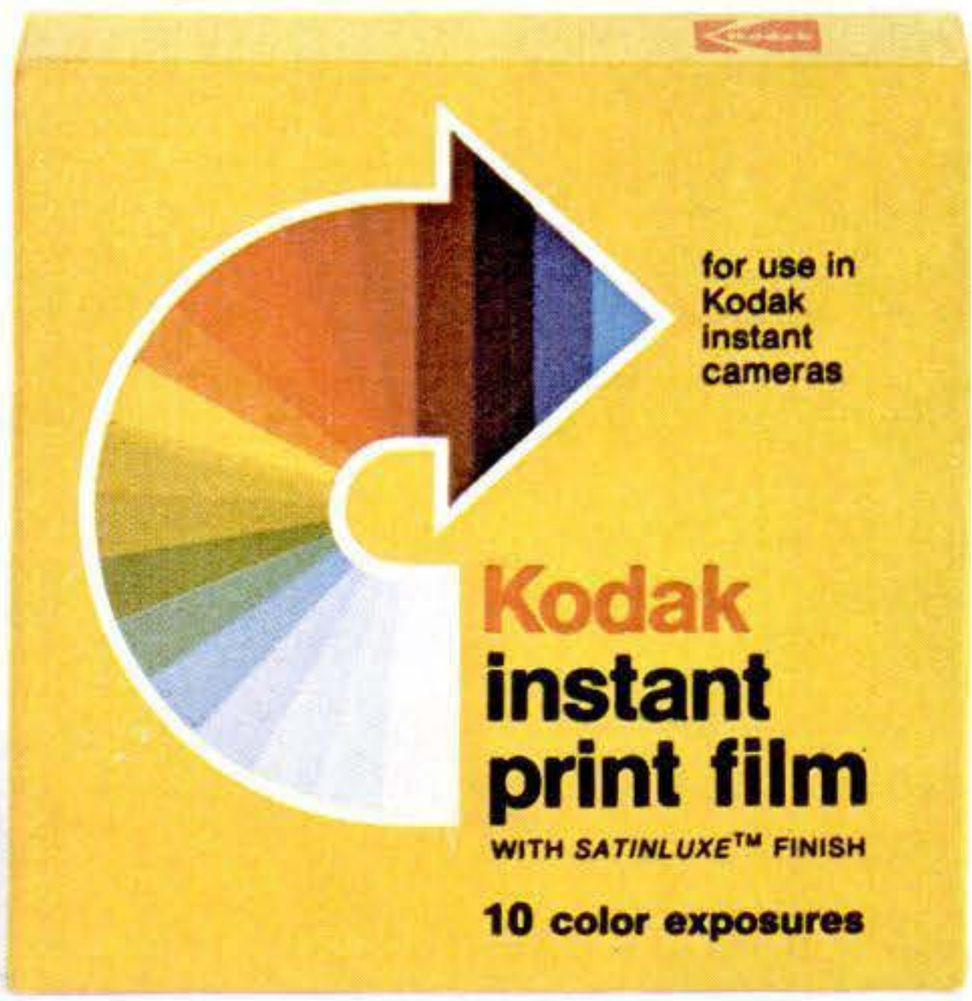

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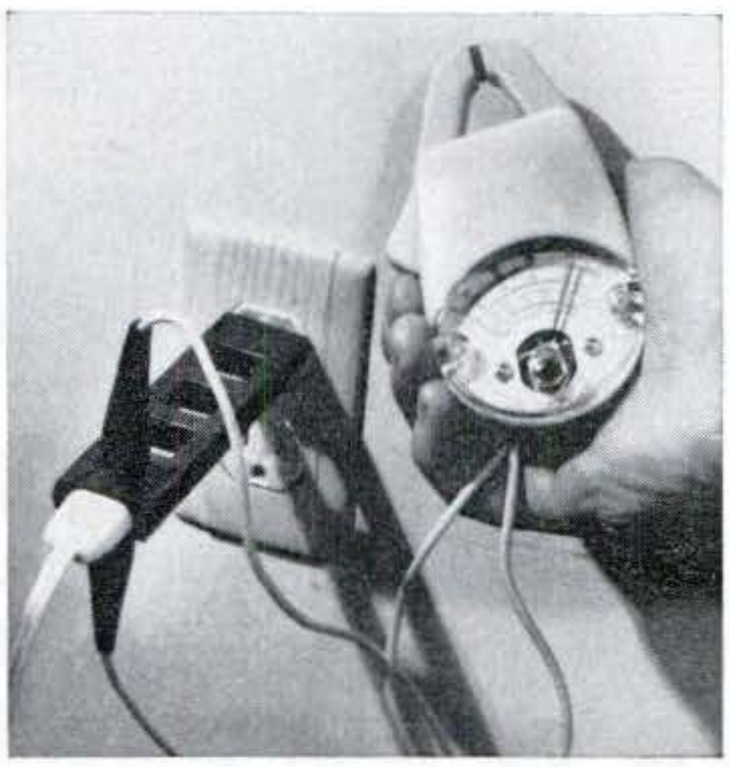
Separate components (such as this range element) should be tested individually. Its voltage (110 or 220) times current you read should equal its wattage.

The voltage and resistance scales of these meters are basically similar to *VOM's* discussed in past articles. And the same testing procedures are used. With the voltage off, you insert leads into the proper jacks. When you're making a resistance test, the power should remain off throughout the test.

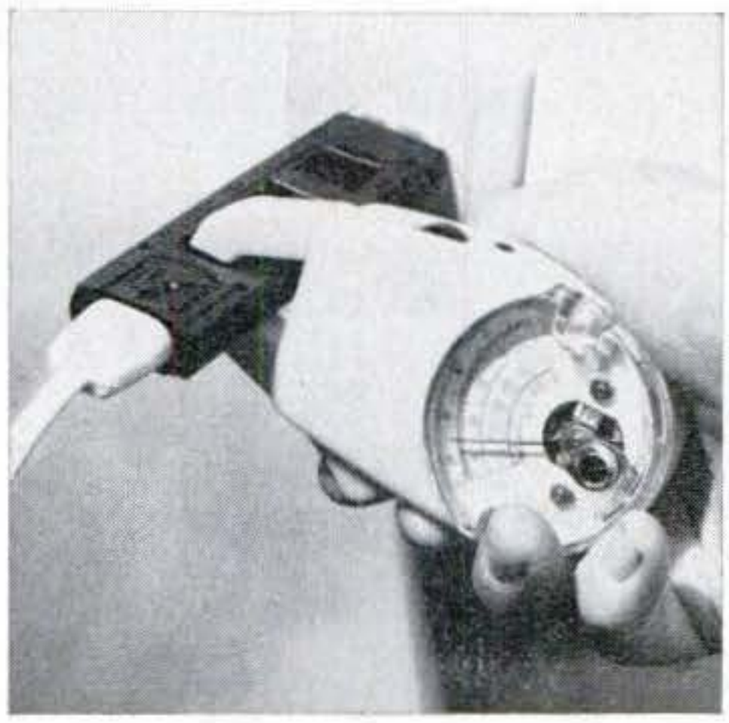
Energizer accessory

This little plug-in device from Amprobe is designed to increase the range of the scales on your meter, but I rate its safety factor equally important. First of all, for appliances in the home, it provides a simple splitter. It also has coils molded within the body to multiply the reading of the current flowing through it by five and ten times. This allows you to read relatively small currents more accurately and easily. The energizer also has two openings that allow you to make voltage tests safely without disconnecting the appliance. To use it, just plug the appliance into the energizer, insert the meter leads into its two jacks, and plug the energizer into the wall outlet. Turn the appliance on and you can then take the voltage reading under load.

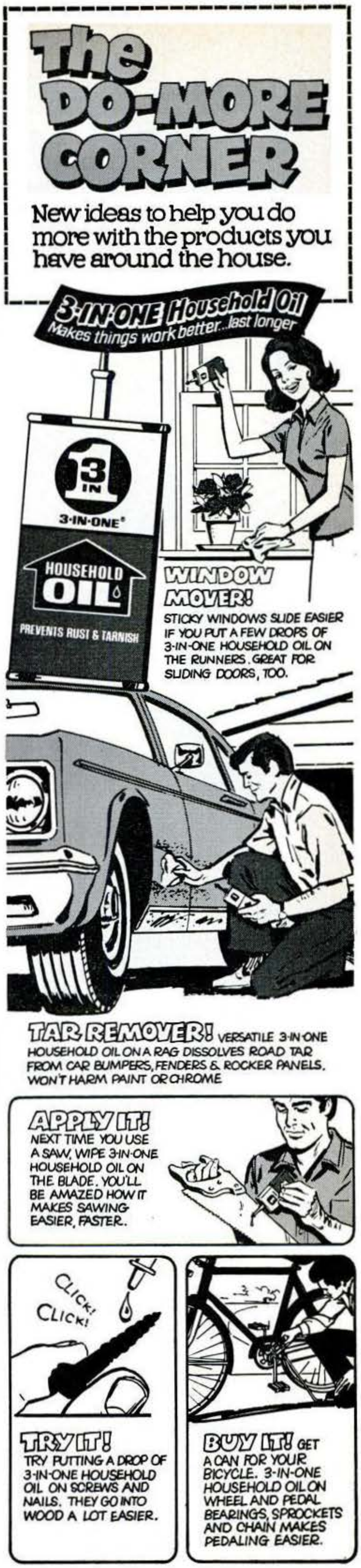
Now that these meters are available at a reasonable price, they're well worth your consideration—you can use them either as an addition or as an alternative to a standard VOM. PS



Amprobe's Energizer ($9.50) is used between socket and the appliance under test. Voltage test leads just plug into it.



Three test slots in Energizer allow Amprobe Jr. meter ($39.50) to accurately check low current levels.



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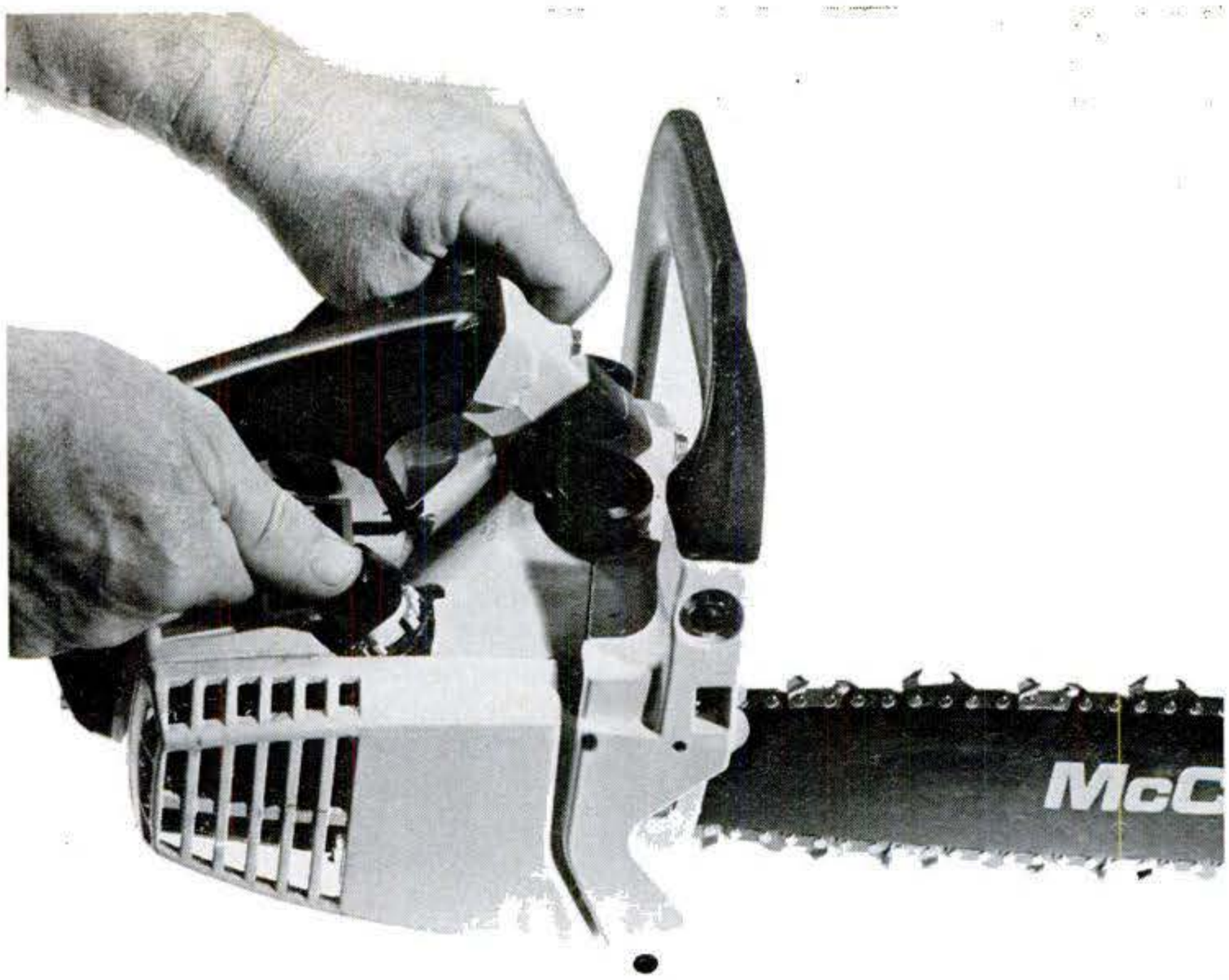

Chain-sharpening stone presses against top face of teeth when button is depressed (above). To take best advantage of blade brake, keep hand at top of grip (right).

Self-oiling, self-sharpening **light chain saw**

Do you tend to forget to push a chain oiler? Do you lack the inclination to file sawteeth after each use? And do you like the added safety of a chain brake? The new Mac 140 chainsaw from McCulloch may be just the saw for you. A 2.0-c.i.d. engine and a 14-inch bar give the Mac 140 that little extra power and reach that take it out of the flyweight class.

I liked the automatic chain oiling with its supplemental manual oiler for tough going. Automatic oiling is a blessing when you're cutting where you must keep your eyes on what's going on.

The semi-automatic chain sharpener consists of a round stone mounted in a spring-loaded cartridge. To use it, you press a button with the saw running at two-thirds throttle and watch the sparks fly for about 10 seconds. A click adjustment lets you readjust the stone for wear.

A special chain is required for this type of sharpening, and the tooth profile is different from that of most chains, because the sharpening is done on the upper face of the top plate of the tooth as the tooth comes around the sprocket. Since each tooth also has a side face that can't be reached by the stone, you'll eventually have to touch up with a file. This chain is just a trifle rougher in cutting, however.

The chain brake is a brake band around the clutch drum that clamps down in a fraction of a second if the saw kicks back against your hand and triggers the spring release.

The Mac 140 lists at $179.95. It's manufactured by the McCulloch Corp., Box 92180, Los Angeles, Calif. 90009.—*E. F. Lindsley*

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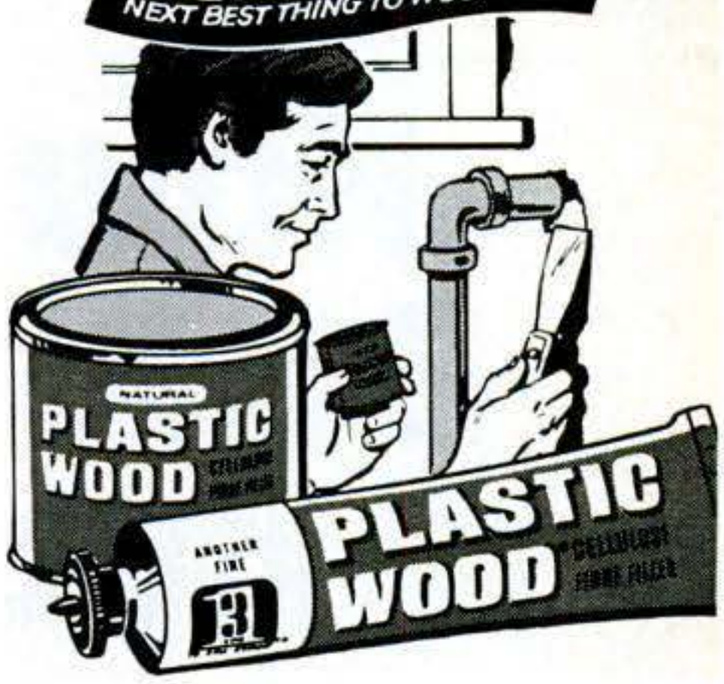

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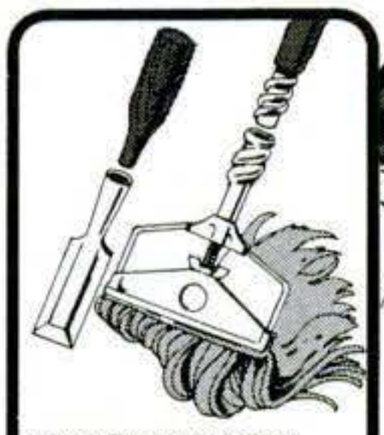

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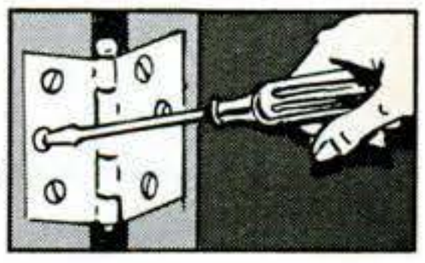

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Wood-stove secrets

[*Continued from page 117*]

pictured here acquitted themselves well in delivering a relatively constant heat output, and all require less manipulation than their Scandinavian counterparts.

The Scandinavians

The Danes and Norwegians (among others) have been making cast-iron wood stoves for hundreds of years. These units have to be efficient because of the relative scarcity of good firewood and the severe winters common in these countries' northern latitudes. Scandinavian ingenuity has produced airtight stoves with two favorable characteristics—a relatively large surface area (often increased by the use of cast-in-relief designs or textured patterns) for improved heat transfer, and a horizontal baffle plate between the top of the firebox and the flue collar.

The baffle increases the "residence time" of the hot smoke and wood gases, so their heat can be transferred to the upper section of the stove body and out into the room instead of being "lost" up the chimney. In fact, many Scandinavian stoves incorporate an arch-shaped, rectangular, or integral heat exchanger above the firebox to extract as much as is practicable from these hot flue gases as they snake their path around this plate.

In consequence, Scandinavian airtight stoves, such as the ones pictured here, have a good reputation for efficiency. However, anyone installing this type of stove should be warned against trying to improve its efficiency even further by adding a heat-exchange device or an especially long run of stovepipe (or even a short run with more than one or two elbows). You *may* get increased efficiency if you attempt one of these "tricks," but you will also decrease the flue gas temperature to below the 200° F or so required to maintain a decent draft in your chimney. Also, creosote will undoubtedly form in your pipes quite rapidly, making frequent cleanouts necessary.

All five Scandinavian units covered here are manually controlled. Since none of them is fitted with dampers—unless it's a combination stove/fireplace unit (the Morso 1125 and the Jotul 4)—the part you control manually is the air-inlet or draft control. This limits the supply of oxygen to the fire and thus the amount of heat delivered.

Continued

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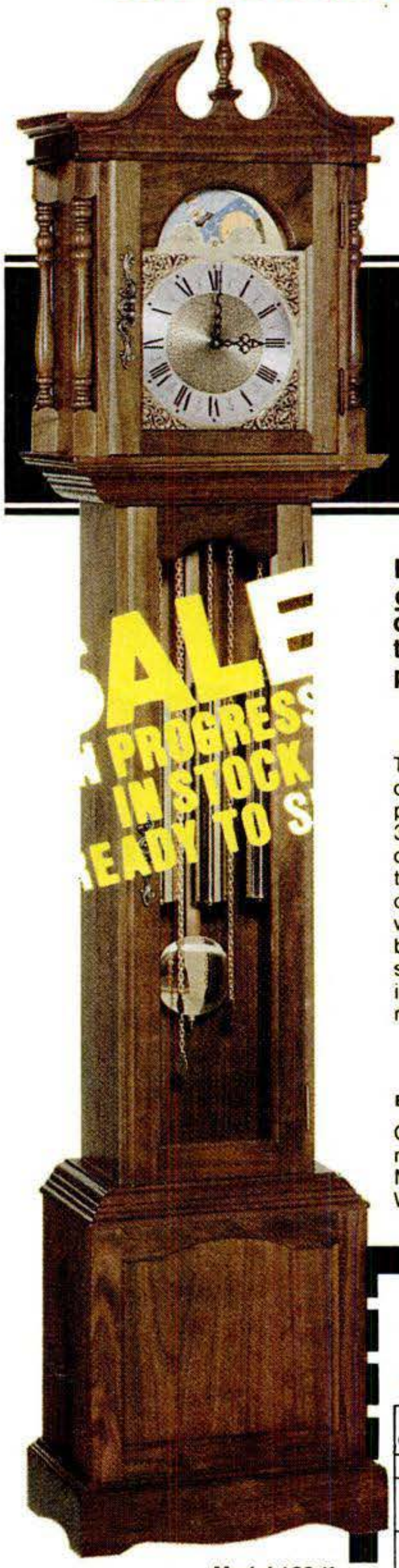

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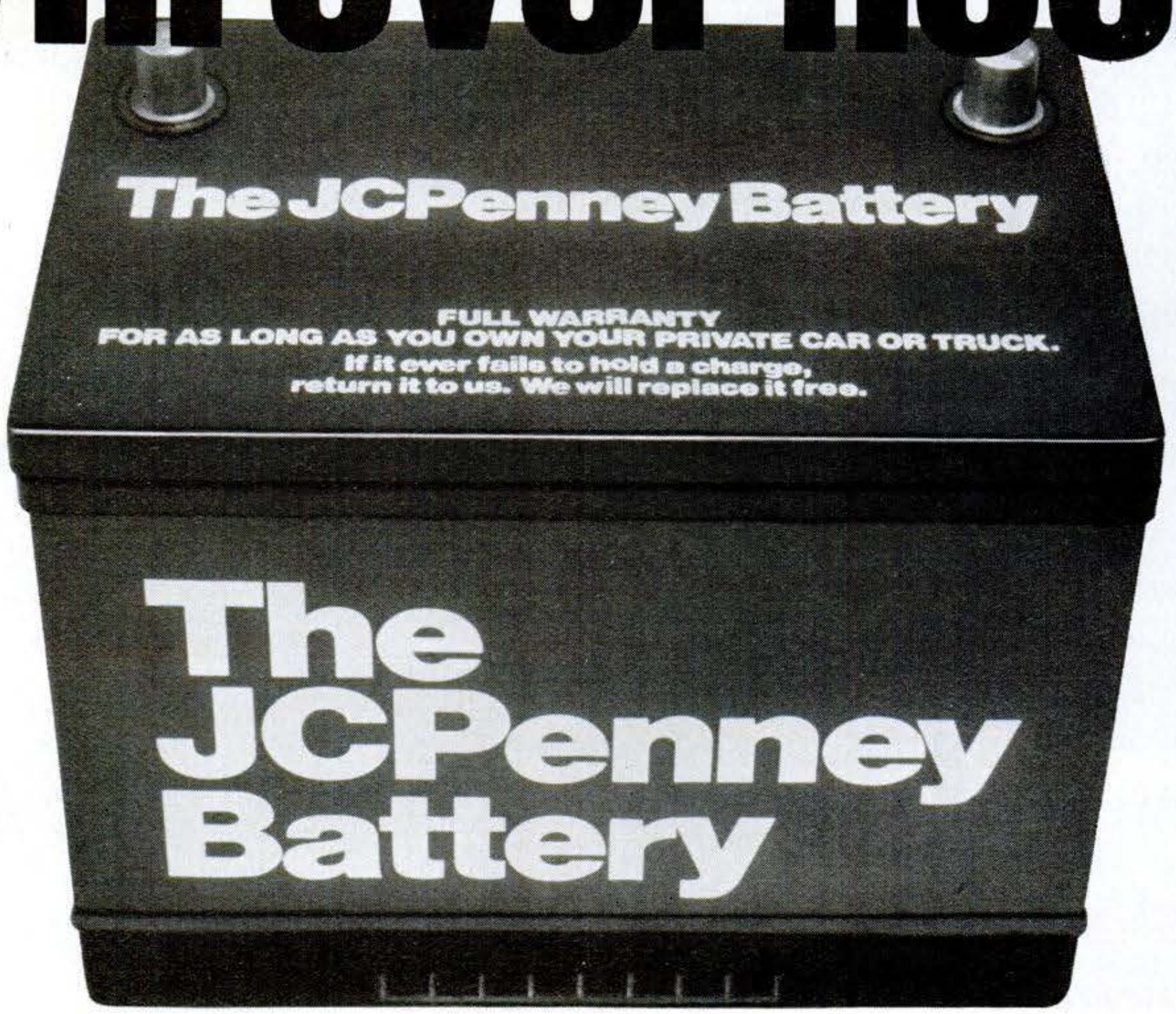

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[*Continued*]

The Jotul stoves use a rotatable, variable-sector type of draft control, while the Morso 1BO and Lange 6302K employ a circular plate that moves in and out on a perpendicular screw to vary the amount of combustion air. Both systems are simple, durable, and work very well. The Morso 1125 works differently, varying the amount of air coming in above and below the closed doors by means of a curved cam.

Once you've got a hot bed of coals, operating the Scandinavian units is quite simple and straightforward. You must occasionally adjust the draft control, however. For example, I found it best to open the draft control to a fairly wide setting after inserting a fresh load of wood. Keep it open for 15 to 20 minutes or so until the fire is going nicely, and then turn it down to the desired setting. Sometimes it is also necessary to turn the setting down even further when most of the wood has turned to charcoal.

Don't get the idea that this means you have to constantly fiddle with these stoves to get steady heat out of them—once set, a minor draft adjustment every few hours is usually sufficient and frequently unnecessary. The Scandinavian philosophy is that the user should "relate" to the stove, and that a properly attuned human being is the best "automatic" control device. There is certainly a lot of truth in this, but in my judgment it applies equally to automatically regulated units. Far from being soulless appliances, wood stoves, regardless of their appearance or design, have personalities of their own, and all require intelligent observation and response to their behavior if you're to get the best out of them. PS

SOURCES OF WOOD-BURNING STOVES

Ashley: Ashley Automatic Heater Co., Box 730, Sheffield AL 35660. **Defiant:** Vermont Castings, Inc., Box 126, Randolph VT 05060. **Jotul:** Kristia Associates, Box 1118, Portland ME 04104. **Lange:** Scandinavian Stoves, Inc., Box 72, Alstead NH 03602. **Morso:** Southport Stoves, 248 Tolland St., East Hartford CT 06108. **Norwester:** Washington Stove Works, 3402 Smith Ave., Everett WA 98201. **Riteway:** Riteway Mfg. Co., Box 6, Harrisonburg VA 22801. **Warm Morning:** Locke Stove Co., 114 W. 11th St., Kansas City MO 64105.

FOR FURTHER READING

Energy for Survival, by Wilson Clark. Anchor Press (Garden City, N.Y.).

Heating with Wood, by Larry Gay. Garden Way Publishing (Charlotte, Vt.).

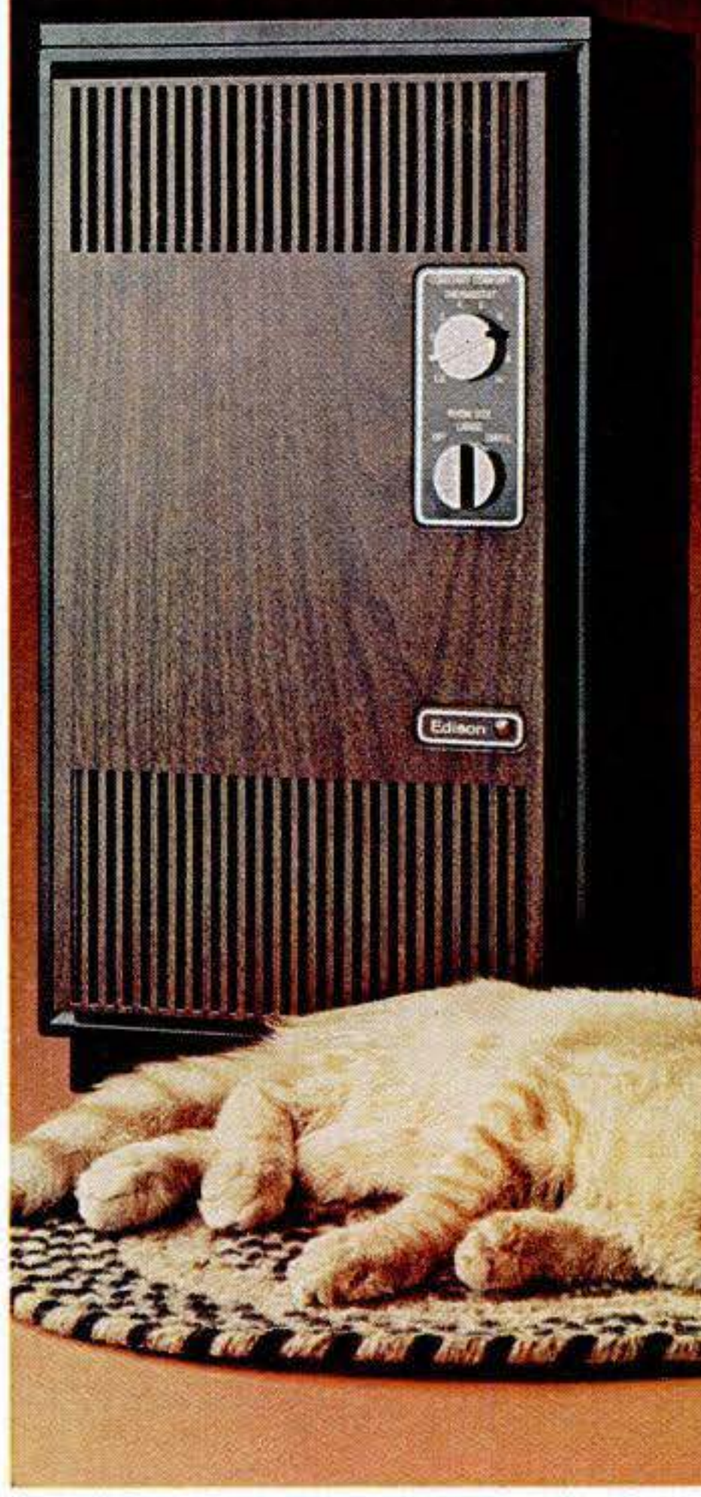
Home Energy How To, by A. J. Hand. Popular Science/Harper & Row (New York, N.Y.).

Modern and Classic Woodburning Stoves, by Bob and Carol Ross. Overlook Press (Woodstock, N.Y.).

The Woodburners Encyclopedia, by Jay Shelton and Andrew B. Shapiro. Vermont Crossroads Press (Waitsfield, Vt.).

Woodburning Quarterly, James R. Cook, ed. (8009 34th Ave. S., Minneapolis, Minn. 55420).

The Edison Comfort Sensor.



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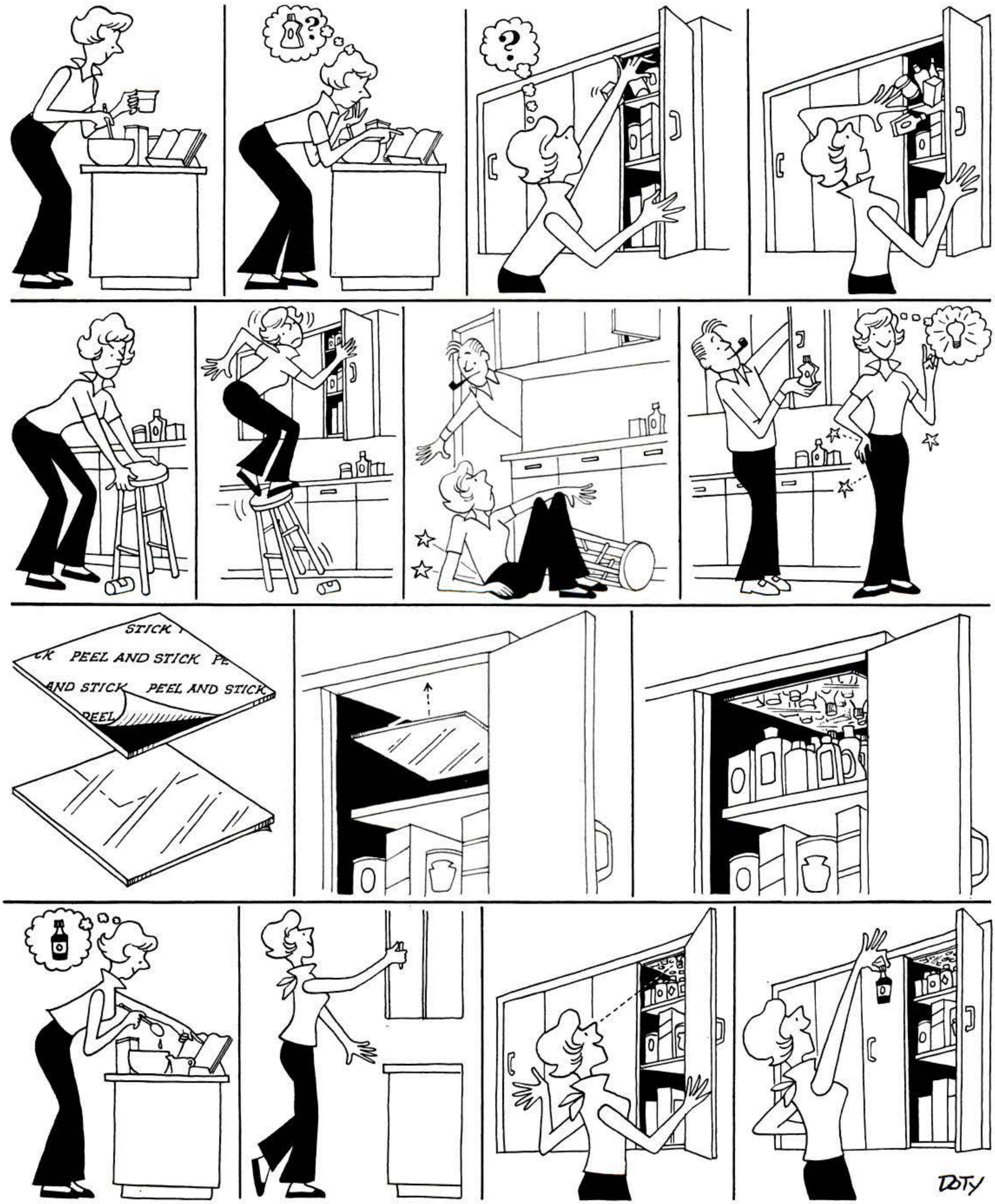

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These questions used to really stump me. That was a few years ago.

My wife and I then lived in Denver, Colorado, at 2545 South High Street. We paid $135 a month rent for a cramped, tumbled down house. My wife was expecting our second child and we were flat broke. I felt desperate and forced into a corner. I had to borrow $150 from my father and another $150 from my father-in-law just to buy the groceries and pay the rent. If that wasn't enough, I was several thousands dollars in debt.

Things are much different now. Last year I could have retired and lived off the income of my one million dollars in real estate holdings. (Incidently, almost all of the income from the real estate is tax free).

Since I had worked 20 to 40 hours a week, I know that I didn't work even 10 times longer or harder than you. And with my C-average from Ames High School (located in Ames, Iowa). I'm quite certain that I'm not any smarter than you.

If hours, efforts, or brains are not what separates the rich from the average guy who is swamped with debts and very little income, then what is?

I learned the answer to that question from an old fellow in Denver. This fellow worked in a drug store stocking the shelves. Very few people knew that he had $200,000 in the bank, all of which he had earned starting from nothing.

Within a year after meeting him, I was told and shown the same thing by a young man who had recently earned over a million dollars. By this time, I began to realize that what I was being shown was truly a remarkable and workable way to grow rich.

I began to apply the principles and methods I had been shown. The results were amazing. I couldn't believe how easy it was, in fact it seemed too easy.

But then I met an elderly lady (83 years old) who, although not very smart, has made $117,000 using the same formula.

I then figured my beginning wasn't luck.

For three and one half years, I worked hard to refine and improve on the formula that I had been shown, so that it would be easy to get quicker results.

As I did this, my assets multiplied very rapidly (160 per cent per year) to the point that I didn't have to work any longer.

I guess I am bragging now, but I did start spending alot of time in our back yard pool, traveling around the country, and doing a lot of loafing.

Then one day a friend asked me how he could do what I had done.

So I began to outline the formula that I had improved to show him really how simple it was, and how he could do the same thing.

By the next time he approached me, I had written almost a complete volume on the easy way for him to copy my results.

I wrote this in simple, straight forward language so anyone could understand it.

This time my friend's questions were very specific. (He had already begun buying properties with the formulas I had been giving him). Now he had a property he wanted to buy, but was out of cash. How could he buy it?

I not only showed him how to buy without cash, but by the time the deal was complete, he had $5,000 cash in his pocket to boot.

I also showed him how to buy a $26,000 property for $75 down.

You, or anyone, can do exactly what I did, or my close friends have done; in fact, you may well do it better. (I began doing this in my spare time only).

It doesn't matter where you live or the size of your town or city, my formula will show you exactly how to:

- Buy income properties for as little as $100 down.
- Begin without any cash.
- Put $10,000 cash in your pocket each time you buy (without selling property).
- Double your assets every year.
- Legally avoid paying federal or state income taxes.
- Buy bargains at ½ their market value.
- Allow you to travel one week out of every month.

When you send me a check or money order for $12, I will send you all my formulas and methods, and you are free to use them anywhere and as often as you would like.

Now if you were a personal friend of mine, I know you would believe me and not need any kind of guarantee, but since you don't know me personally, I will guarantee that you will be completely satisfied and that my formula will work for you if you apply it. I will back up that guarantee by not cashing your check for 30 days, and if you for any reason change your mind, let me know and I will send your uncashed check back.

You may well ask, why am I willing to share my formula for wealth? Well, because many of you will probably seek further consultation and direction from me as your wealth rapidly grows and my consultation fee adds to my fortune.

But you shouldn't care if I profit as long as you profit. And I guarantee that you will.

By the way, if you feel a little uneasy about sending me a check or money order for $12.00, simply postdate it by 30 days which will completely eliminate your risk.

If you would like to check some of my references I have listed a few:

Tracy Collins Bank & Trust, 107 South Main, Salt Lake City, Utah Attn.: Beverly Smith, Manager: Charles F. Huber, Certified Public Accountant, 1850 Beneficial Life Towers, Salt Lake City, Utah. 801-531-8286.

To order simply write on any size paper "Financial Genius", your name and address including zip code, place it in an envelope and send it to Mark O. Haroldsen, Inc., Dept. E-856, Tudor Mansion Building, 4751 Holladay Boulevard, Salt Lake City, Utah 84117. Be sure to enclose a check or money order for $12.00.

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[Continued from page 85]

Woodland Hills, Calif., introduced a screen material called Liteguard, whose aluminum surface has an optical (plastic) coating that can be cleaned. The coating boosts reflectively up to 92 percent—seven percent higher than Kodak's (or similar) uncoated Ektalite screens. The plastic also prevents oxidation, which after 18 months cuts reflectance 30 percent on fragile, bare-aluminum screens.

The 50- and 64-inch Liteguard screens I used were made for Extron by two Florida firms, J. C. Siva, Inc.; and Optivision, Inc. Both screens have spherically curved surfaces and provided bright, even images. Some screen makers, however, put a single horizontal bend or compound bends (top, bottom, sides) in their products. These nonspherical shapes are cheaper to make, but often produce hot spots (glare) or corner shadows.

Another screen tested, of parabolic curvature, made by Schudel, Inc., uses an aluminum-coated plastic. It produced an exceptionally bright image that, unlike the spherical screens, faded more abruptly toward the edges. PS

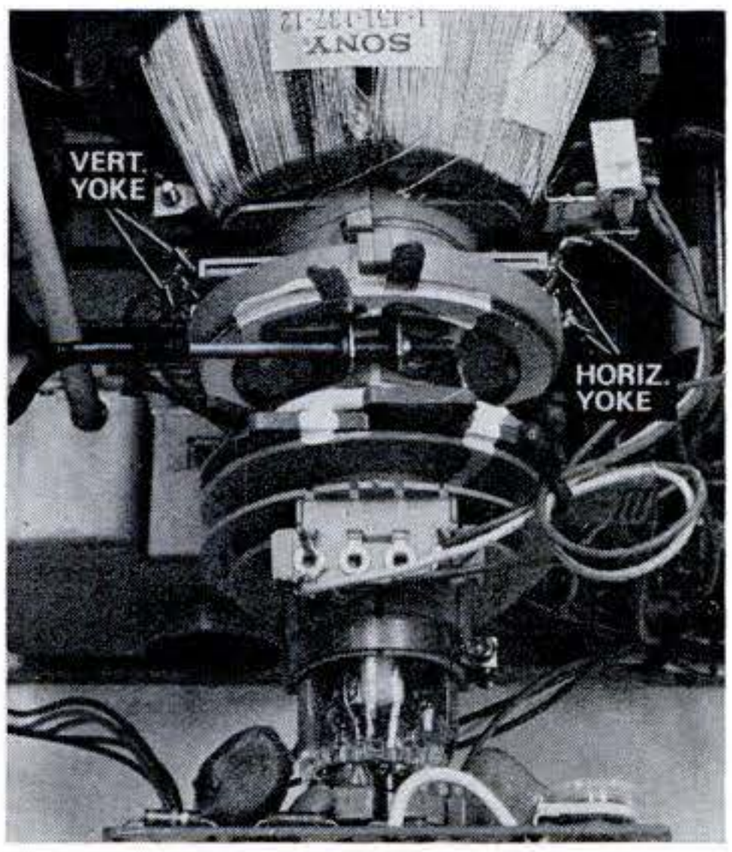
SOURCES FOR PARTS AND PLANS

A growing number of firms offer projection-TV components. This is a list of the necessarily limited number of companies whose components were tested by PS.

Plans and components: Extron, 8831 Sunset Blvd., W. Hollywood CA 90069; **Spearsonic Electronics Corp.,** 40 W. 20 St., New York NY 10011.

Spherical and parabolic screens: Extron (see above); **Schudel Associates,** Box 99697, San Diego CA 92111; **J. C. Siva, Inc.,** 1570 N.E. 131 St., N. Miami FL 33161.

Lenses: Extron, Schudel, Spearsonic (see above); **Buhl Optical Co.,** 1009 Beech Ave., Pittsburgh PA 15233; **Edmund Scientific Co.,** 705 Edscorp Building, Barrington NJ 08007; **3M Visual Products Div.,** 3M Center, St. Paul MN 55101.



Leads to horizontal or vertical yokes may need to be reversed by a technician to correct optical image changes. Arrows show leads in Sony's 1541R.

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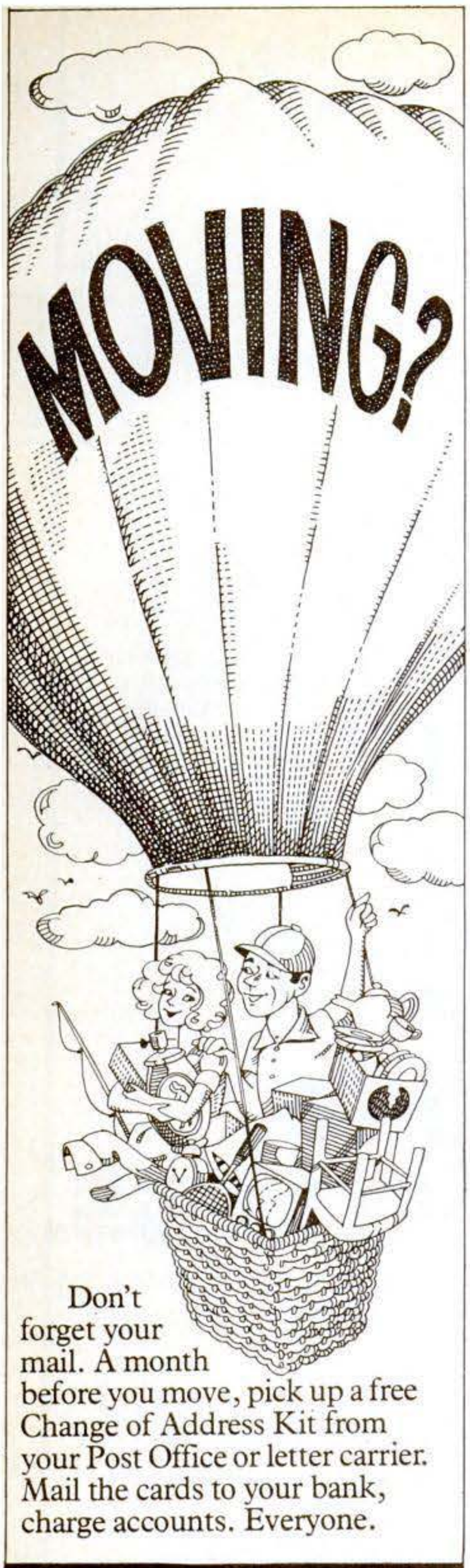

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[Continued from page 91]

a keyboard. Information from the computer is converted to a video signal on the board which you connect to a TV monitor or converted TV set. The result is graphics—pictures, drawings, maps—and regular or special characters, such as Greek, printed across the TV screen. And, by adding the company's Super Dense option on the board ($39), you can have one location in your memory represent one phosphor dot on the TV screen. With that type of resolution, the system draws just about anything.

Instructions for all three boards are clear and you'll spend about four to five hours getting it all together. Details on how to use it, however, are, at the time of this writing, incomplete and "super dense." This, say its makers, is being corrected.

When you first turn on a computer, you know what happens? Nothing. It just doesn't know what to do without instructions. And to give it instructions manually—using the front control switches—could take hours for even simple things. An alternative is a monitor board that contains programs you can use immediately after turning on the computer.

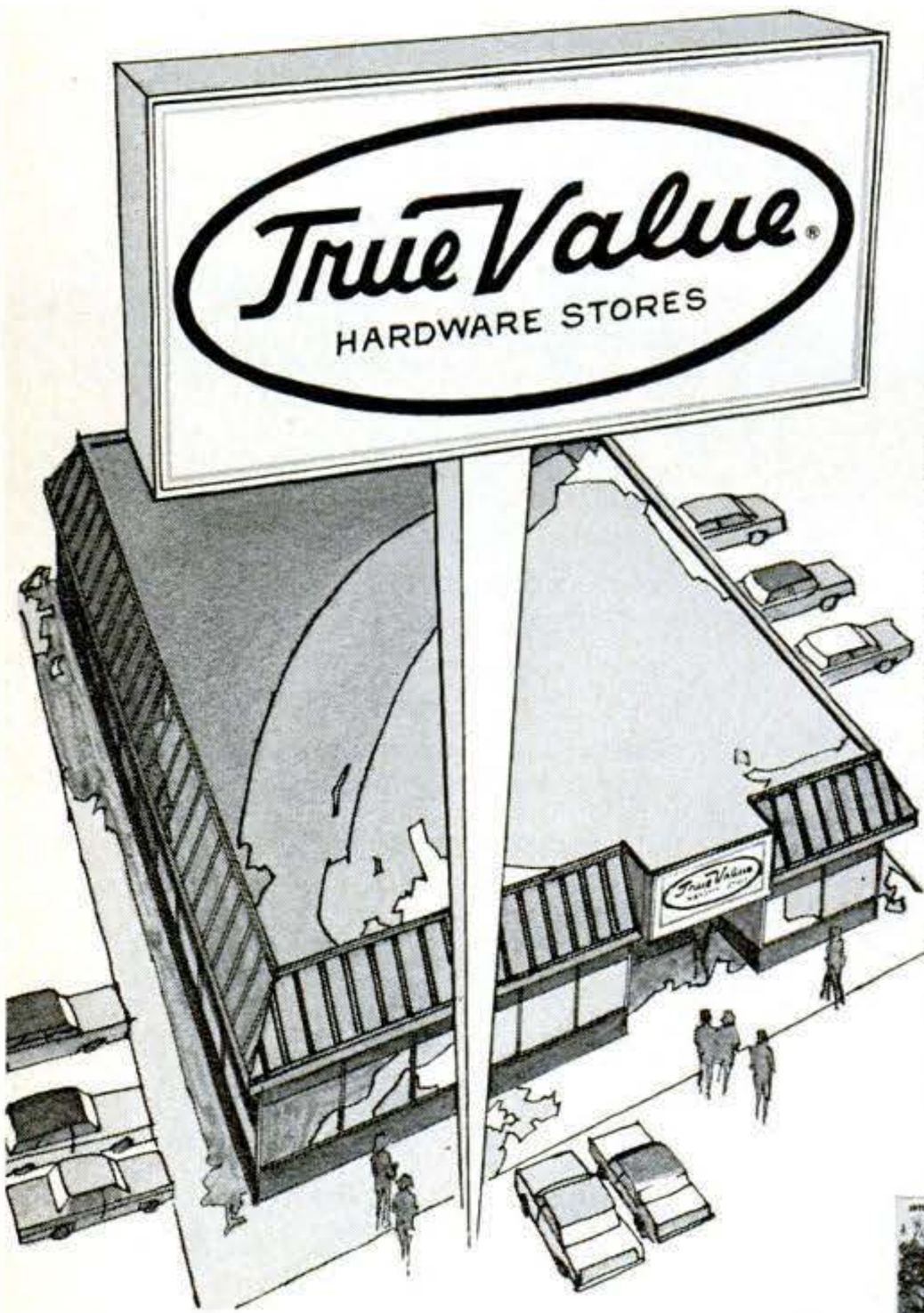
Vector Graphics has a monitor board called the Reset and Go. With it, you just hit the reset button on the computer when you first turn it on, and the board automatically takes over and allows you to give immediate commands to the computer (such as displaying or loading up memory addresses, etc.). The board supports a TV terminal and tape system, but unlike most other monitors, it's designed to let you use your existing I O boards. Naturally if you've already got other I O boards, this is a good way to go.

Finally there is the TDL ZPU, using a Z-80 microprocessor, and monitor board system. With just these two boards, you have an entirely new, more sophisticated computer. The Z-80 can accept many more instructions than the 8080 (which is normally used), so it is much more versatile; comparable programs written for the Z-80 can be much shorter and faster.

The monitor board that goes with it does just about everything you'd want when first turning on the computer—memory tests, register and memory examination, data entry, and over 20 more instant instructions—just by your hitting a specific key on the keyboard. The board controls any type of peripheral you'd like and, under program or switch control, in any order.

TDL has made building these boards easy and they offer a large program package as well. You might want to consider their 12K BASIC with "speech" command (it uses the Computalker speech board) if you now use MITS BASIC (most popular form of BASIC used by hobbyists). MITS, unfortunately, will not run on Z-80 systems (at least the 3.2 version I tried won't).

You may think that after spending a few hundred hours and soldering well over 10,000 connections, I'd be tired of playing computer. I'm not. With each board, a new and practical job is available for my system to do. And getting it to do all these incredible things is all the fun. PS



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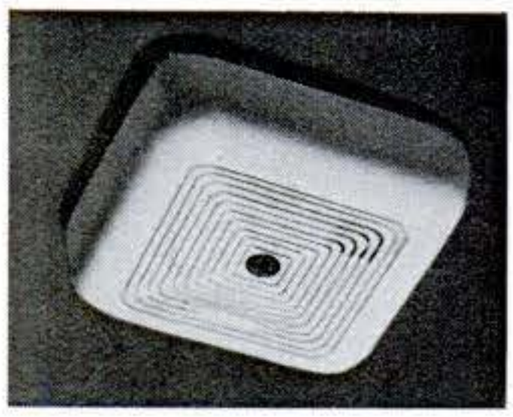

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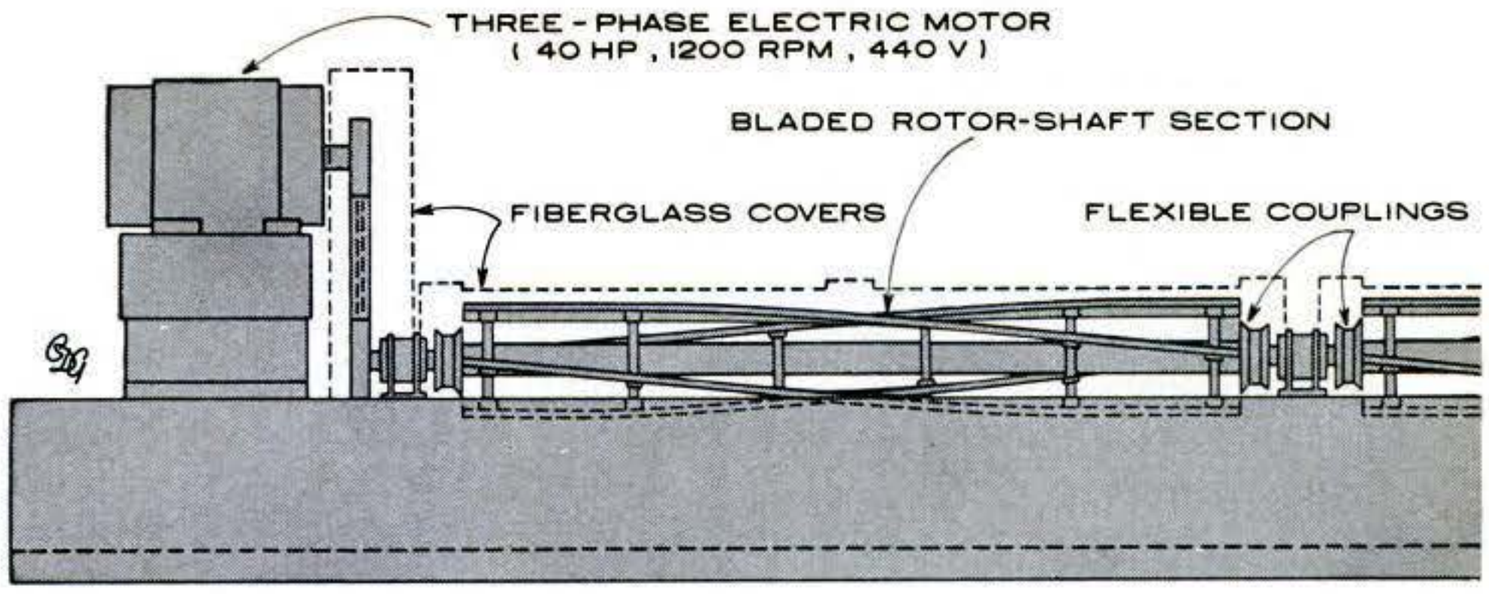
Rotary water cooler



Electrical generating plants and many large industries use enormous quantities of water for equipment-cooling. But to avoid thermal pollution, that warmed water must itself be cooled before it can be released into a lake or river. As pollution-control laws get stricter, more and more cooling towers are being built—to cool the coolant. The catch is that the towers, too, have a harmful impact on the environment: They cause a drift of airborne particles downwind; they generate a plume of condensing vapor that spreads over the area; and they're big and usually ugly.

A new approach to cooling large volumes of water, the rotary cooler shown above may offer a better way to rid water of excess heat. Made by Cherne Industrial, Inc., of Edina, Minn., it looks like an old-fashioned rotary mower big enough to mow a football field in one pass. Actually the device is modular; each module is 10 feet long and carries four spiral blades on a 15-inch-diameter shaft.

The turning rotors lift hot inlet water from a trough below and spray it around and down into a reservoir. Fiberglass shields over the rotors help direct the spray. The action of the rotors induces a considerable draft (about 10 mph), which facilitates the cooling.

Test results

Small-scale tests, in progress since May, 1973, indicate that plume and drift problems are considerably less than with conventional cooling towers. Also, since the installation is only a few feet above ground, the visual impact is minor. The rotary system may even be more economical to install. A system at Inland Steel Co. in East Chicago, Ind., cost about $600,000 less than other methods of water-cooling, according to the company. Now, further large-scale tests, using 12 modules in close proximity, are planned to test the cooling characteristics and the environmental impact of the rotary cooler.

Funding for the development and testing of the Cherne cooler has been augmented by numerous utility companies (including $4000 from the Electric Company of France) and from various government agencies.—*V. Elaine Smay*

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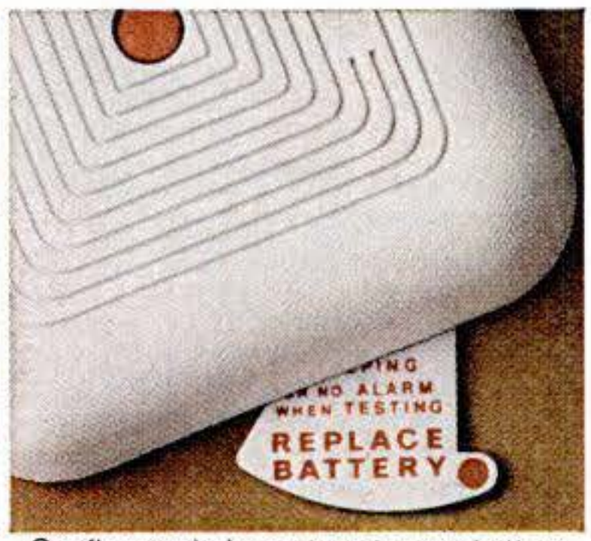

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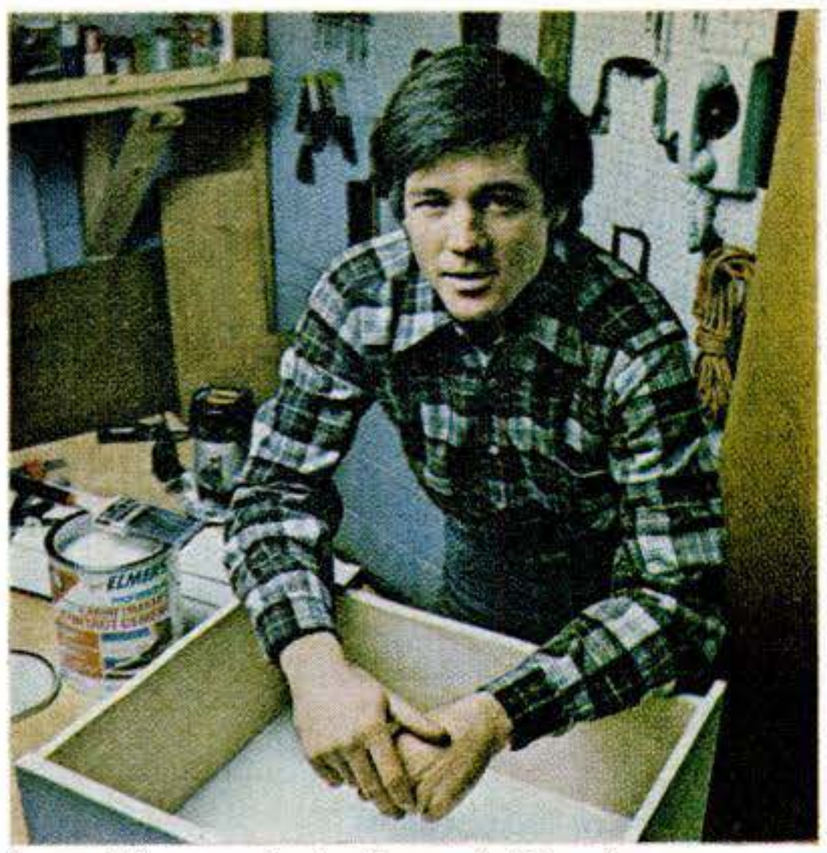

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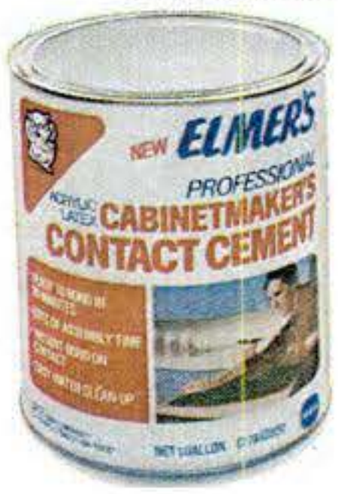

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Digital tuners

[Continued from page 93]

love the Luxman 5T50—it gives LED displays of signal quality, stereo mode, and indicators along its conventional tuning band, but with a digital readout of frequency as well. It's $1500.

If you don't like turning dials or pushing buttons, you'll appreciate the sophisticated electronics in the Toshiba ST-910. All functions are controlled by touching specific areas on the specially coated glass faceplate.

Using these touch sensors, you can do a manual (one channel at a time) or automatic scan up or down the band in 100-kHz steps. You can also have it scan for stereo stations only, ignoring the monaural ones, or pick out up to seven preset stations in its memory. Harder to touch, however, is the price—it's $1800.

Somewhere between a hi-fi system and an airplane cockpit is the $3500 Setton RCS-X1000. The main amplifier circuitry in this two-piece system is connected by a long flat cable (for under-the-rug wiring) to the console control panel. The volume-control levers resemble throttles; LED's show signal levels, center tuning, and volume; and digital readouts display FM frequency, program source, and tone-control levels.

Once you have designed an electronic tuning system, you can make anything control it. But, to date, Sherwood is the only maker that has assigned a microprocessor—a small computer chip—to that chore in the Micro/CPU 100.

Sherwood takes advantage of its versatility by allowing you to program a station's call letters into its memory. The microprocessor can then dial the stations selected when you punch in the call letters. You don't have to remember the frequencies. The processor also controls the automatic scanning system as well as call-letter, channel-frequency, and LED dial-position indicators. That convenience, however, will cost you $2200.

Are the new digitals better? You do get quality sound, but not because of all the goodies. In each case, in these top-of-the-line units, all of the tuning and amplifying circuitry is top-of-the-line—as you would expect at these prices.

But are all those readouts really necessary? Nope. Do they actually help performance? Not really. Do I want one? You bet your life! PS

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Emergency reservoir

Worried about sudden water shortages? Instead of discarding half-gallon plastic jugs, fill them with clean water and store for emergencies. If your regular water supply is interrupted, you can use the jug water for household tasks such as dishwashing and toilet-flushing. For emergency stores of drinking water, use only glass jugs that were food containers. Before drinking, or cooking with, long-stored water, boil to assure purity.—*W. Burton*

Siphon aid

An old rubber glove lets you siphon gas without the risk of getting a mouthful. Slit the tips of two glove fingers, and insert a long siphon tube through one of the tips. Stick about six inches of tubing in the other slit, and tie string around the two glove fingers to secure the tubes. To use, insert the long tube in the donor gas-filler pipe, and hold the glove's cuff tightly around the gas-fill opening. Blow through the short hose to build up air pressure in the tank: The pressure forces gas up and out the long tube. Have a can handy to receive the gasoline.—*L. Braile*

Caulk release

When you have trouble getting caulk to come out of the cartridge, don't force it. The plastic follower inside the tube is probably stuck to the sides. To free it, simply run the tip of a penknife between the follower and the cartridge. Reinsert the cartridge in the gun and caulk away. —*Richard Day*

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The Ultimate Tax Shelter

by
TED NICHOLAS

Tax experts are now referring to a small, privately owned corporation as "The Ultimate Tax Shelter." This is especially true since the passage of the Tax Reform Act of 1976. This law makes most former tax shelters either obsolete, or of little advantage. Investments affected include real estate, oil and gas drilling, cattle feeding, movies, etc. These former tax shelters have lost their attractiveness. Aside from that, these tax shelters required a large investment. Only a small segment of the population could benefit from them.

I've written a book showing how you can form your own corporation. I've taken all the mystery out of it. Thousands of people have already used the system for incorporation described in the book. I'll describe how you may obtain it without risk and with a valuable free bonus.

A corporation can be formed by anyone at surprisingly low cost. And the government encourages people to incorporate, which is a little known fact. The government has recognized the important role of small business in our country. Through favorable legislation incorporating a small business, hobby, or sideline is perfectly legal and ethical. There are numerous tax laws favorable to corporate owners. Some of them are remarkable in this age of ever-increasing taxation. Everyone of us needs all the tax shelter we can get!

Here are just a few of the advantages of having my book on incorporating. You can limit your personal liability. All that is at stake is the money you have invested. This amount can be zero to a few hundred or even a few thousand dollars. Your home, furniture, car, savings, or other possessions are not at risk. You can raise capital and still keep control of your business. You can put aside up to 25% of your income tax free. If you desire, you may wish to set up a non-profit corporation or operate a corporation anonymously. You will save from $300 to $1,000 simply by using the handy tear-out forms included in the book. All the things you need: certificate of incorporation, minutes, by-laws, etc., including complete instructions.

There are still other advantages. Your own corporation enables you to more easily maintain continuity and facilitate transfer of ownership. Tax free fringe benefits can be arranged. You can set up your health and life insurance and other programs for you and your family wherein they are tax deductible. Another very important option available to you through incorporation is a medical reimbursement plan (MRP). Under an MRP, all medical, dental, pharmaceutical expenses for you and your family can become tax deductible to the corporation. An unincorporated person must exclude the first 3% of family's medical expenses from a personal tax return. For an individual earning $20,000 the first $600 are not deductible.

Retirement plans, and pension and profit-sharing arrangements can be set up for you with far greater benefits than those available to self-employed individuals.

A word of caution. Incorporating may not be for you right now. However, my book will help you decide whether or not a corporation is for you now or in the future. I review all the advantages and disadvantages in depth. This choice is yours after learning all the options. If you do decide to incorporate, it can be done by mail quickly and within 48 hours. You never have to leave the privacy of your home.

I'll also reveal to you some startling facts. Why lawyers often charge substantial fees for incorporating when often they prefer not to, and why two-thirds of the New York and American Stock Exchange companies incorporate in Delaware.

You may wonder how others have successfully used the book. Not only a small unincorporated business, but enjoyable hobbies, part time businesses, and even existing jobs have been set up as full fledged corporations. You don't have to have a big business going to benefit. In fact, not many people realize some very important facts. There are 30,000 new businesses formed in the U.S. each and every month. 98% of them are small businesses; often just one individual working from home.

To gain all the advantages of incorporating, it doesn't matter where you live, your age, race, or sex. All that counts is your ideas. If you are looking for some new ideas, I believe my book will stimulate you in that area. I do know many small businessmen, housewives, hobbyists, engineers, and lawyers who have acted on the suggestions in my book. A woman who was my former secretary is incorporated. She is now grossing over $30,000 working from her home by providing a secretarial service to me and other local businesses. She works her own hours and has all the corporate advantages.

I briefly mentioned that you can start with no capital whatsoever. I know it can be done, since I have formed 18 companies of my own, and I began each one of them with nothing. Beginning at age 22, I incorporated my first company which was a candy manufacturing concern. Without credit or experience, I raised $96,000. From that starting point grew a chain of 30 stores. I'm proud of the fact that at age 29 I was selected by a group of businessmen as one of the outstanding businessmen in the nation. As a result of this award, I received an invitation to personally meet with the President of the United States.

I wrote my book, **How To Form Your Own Corporation Without A Lawyer For Under $50**, because I felt that many more people than otherwise would could become the President of their own corporations. As it has turned out, a very high proportion of all the corporations formed in America each month, at the present time are using my book to incorporate.

Just picture yourself in the position of President of your own corporation. My book gives you all the information you need to make your decision. Let me help you make your business dreams come true.

As a bonus for ordering my book now, I'll send you absolutely free a portfolio of valuable information. It's called "The Incom Plan" and normally sells for $9.95. It describes a unique plan that shows you how to convert most any job into your own corporation. You'll increase your take-home pay by up to 25% without an increase in salary or even changing jobs in many cases. If you are an employer, learn how to operate your business with independent contractors rather than employees. This means that you'll have no payroll records or withholding taxes to worry about. And you'll be complying with all I.R.S. guidelines. "The Incom Plan" includes forms, examples and sample letter agreements to make it possible.

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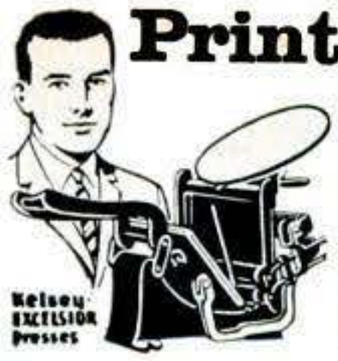

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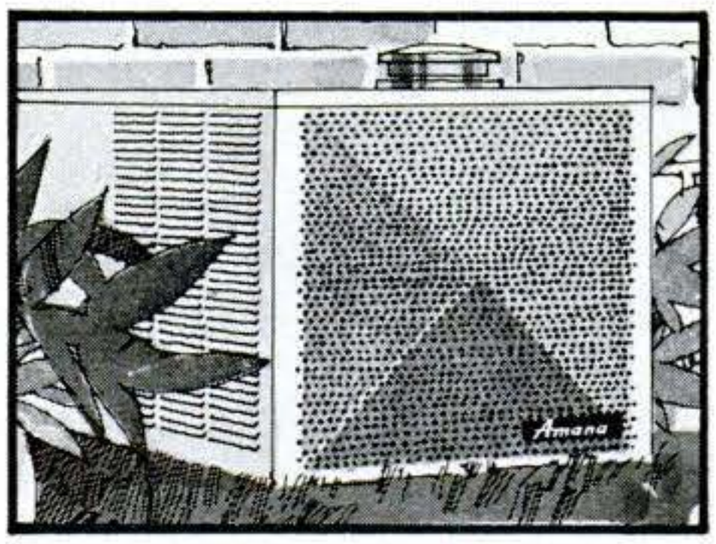

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[Continued from page 83]

there are two oddball tape formats that are incompatible with all other machines. These are used in Sanyo's V-Cord II decks and Quasar's VR-1000 (see photos).

Differences between Beta-format and VHS are relatively minor, but significant enough to make them incompatible. "Both systems have taken similar approaches to double the playing time of their machines," says Thornley Jobe, RCA's special projects manager. But a key difference, he explains, is that the VHS format started out with 250 meters of cobalt-doped ferric oxide tape for two hours of playing time. Beta-format (or Betamax) cassettes have only 150 meters of chromium dioxide (CrO_2) tape for two hours. Both tape formats use the azimuth recording technique (see box).

With either format, when you throw a switch to halve the tape speed and double the record/play time, the width of the video tracks is reduced. That's because at the slower speed each video head overlaps and erases part of the previously recorded track. In RCA's VBT200, for example, the video tracks are recorded 41 microns wide in the SP (two-hour) mode with a slight space between each track. But in the LP (four-hour) mode, each 41-micron-wide video head overlaps the adjacent track 30 percent. The result is a 29-micron-wide playback track instead of 41 microns.

Just as narrow audio-cassette tracks produce noisy sound (hiss) during playback, narrowed video tracks produce noisy pictures (more black and white specks). To minimize this noise, both tape formats have circuits that act on video signals much as Dolby circuitry operates to reduce audio tape hiss.

The video noise-reduction circuits expand or compress signals before they're put on tape. Then during playback the signals are compressed or expanded back to their proper levels. Also, the color signals in both formats are altered before recording and corrected during playback in order to minimize color-signal interference.

I found that Sony's 8200 (Beta-format) and JVC's 3300 deck (VHS) produced similar high-quality pictures on a 25-inch color set. But images from the VHS deck proved to be somewhat cleaner (noise-free) when enlarged to seven feet (diagonally) with an Advent 1000 projection TV. PS

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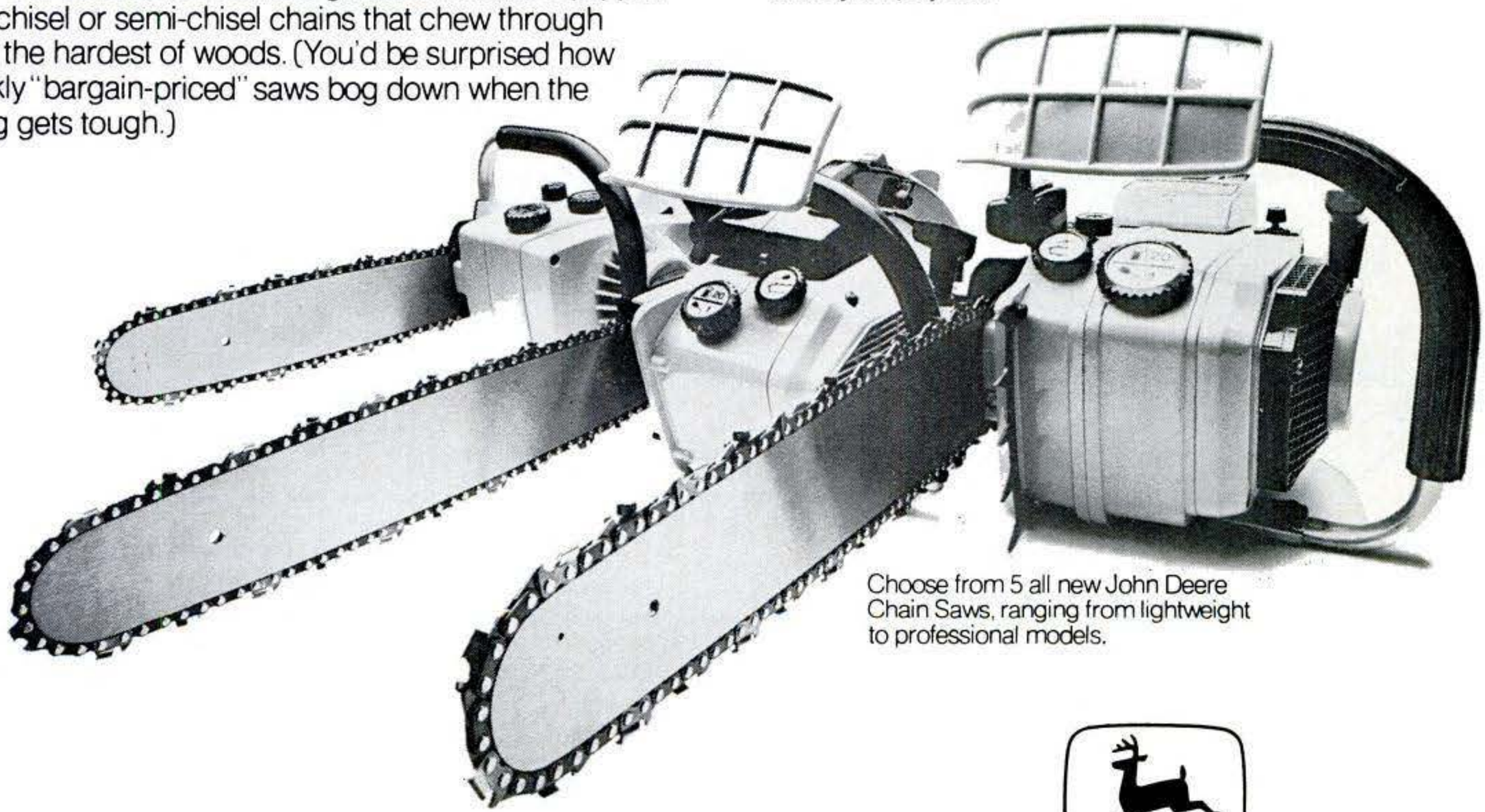

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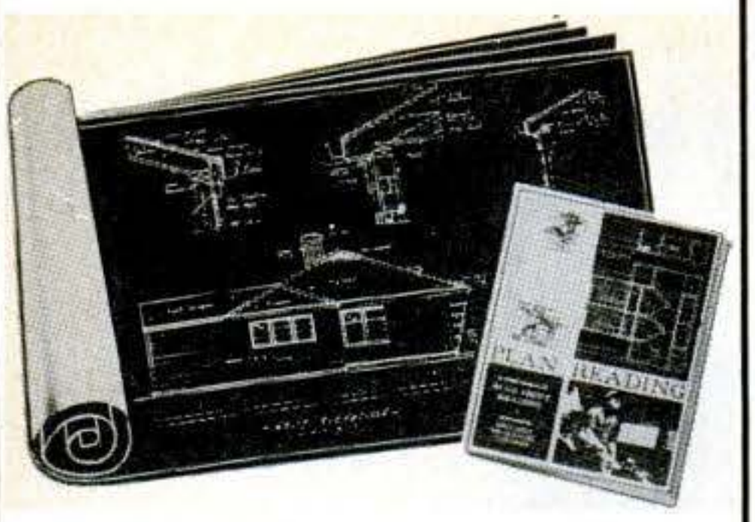

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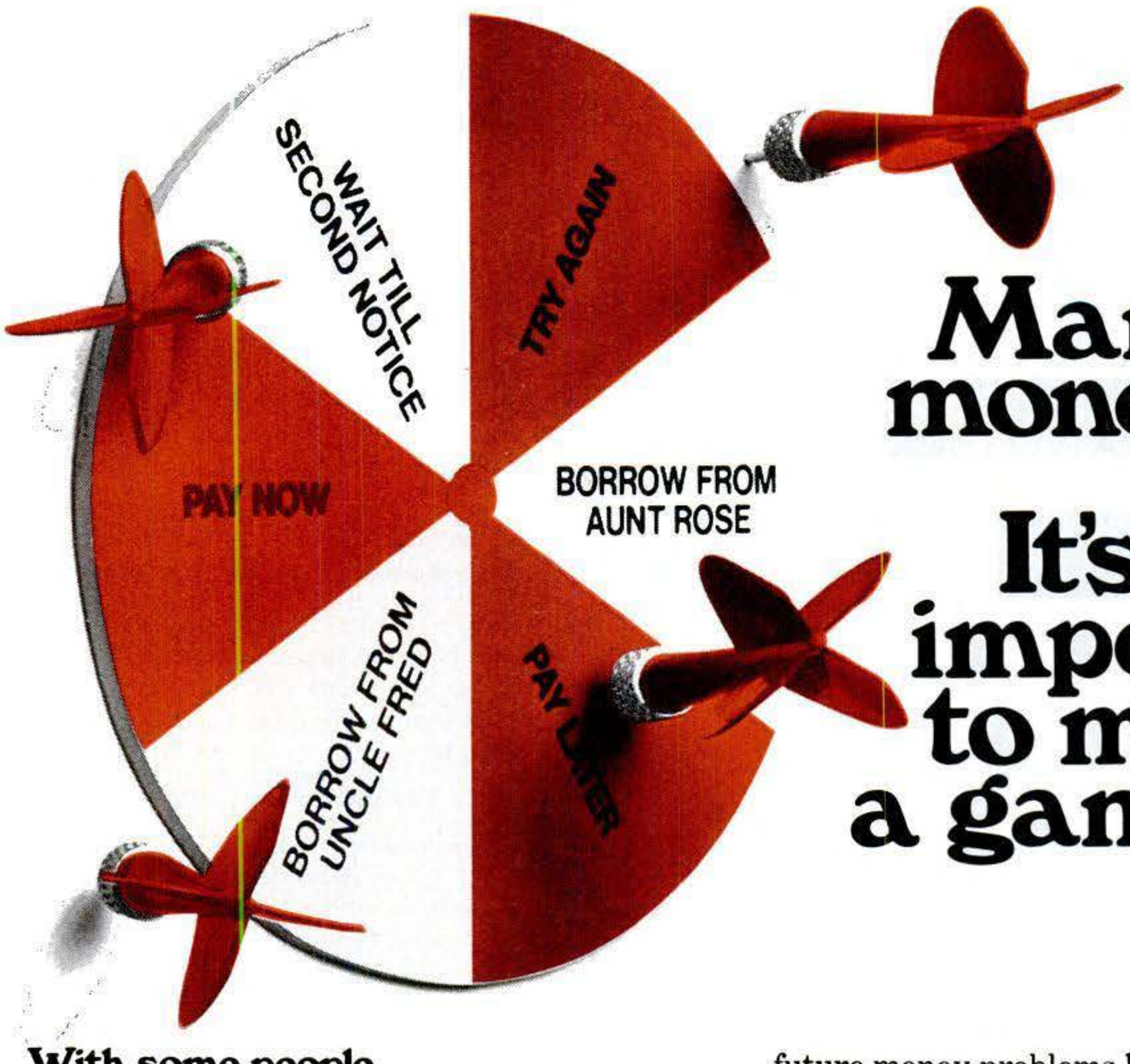

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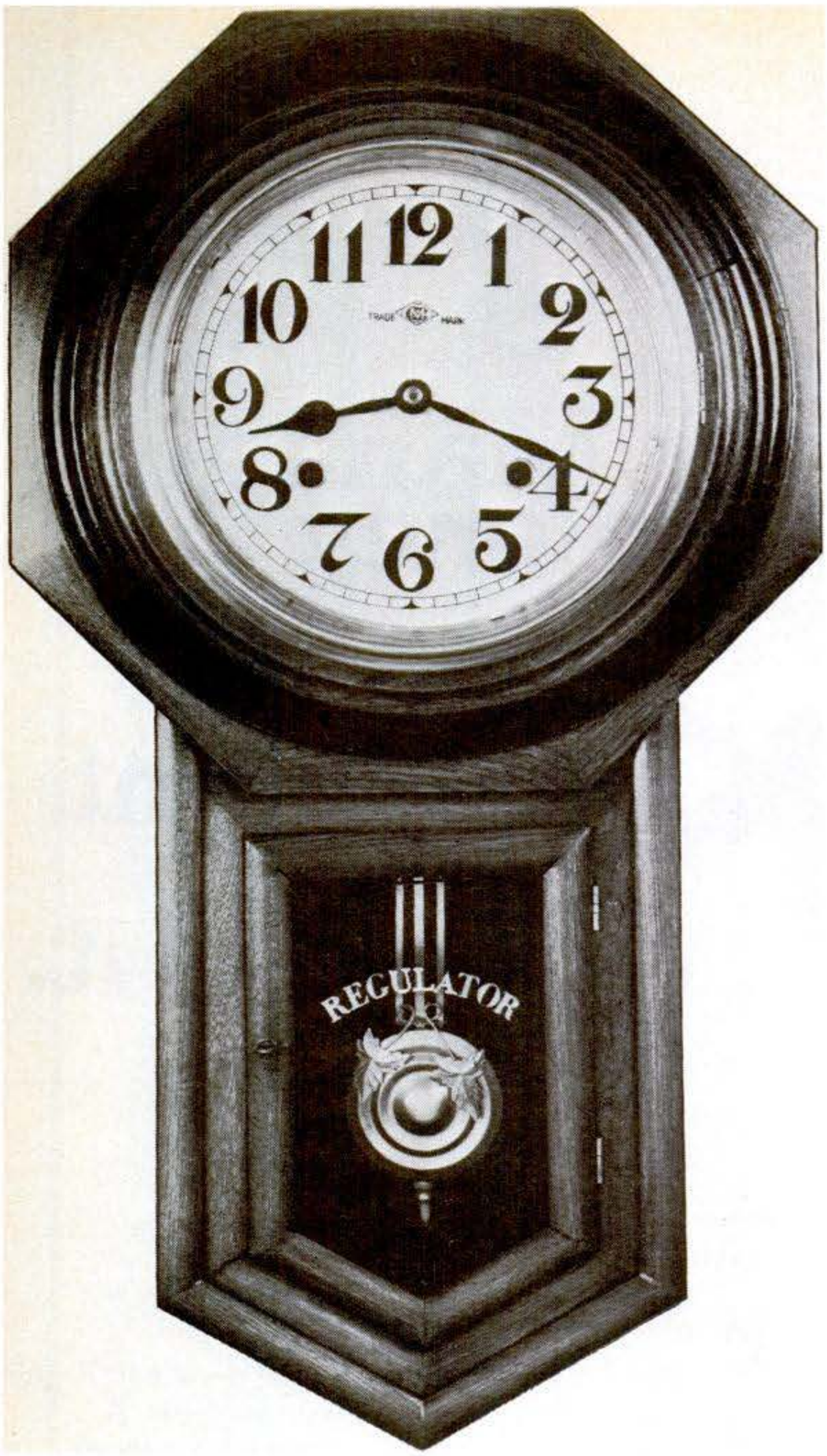

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[Continued from page 88]

some dustcover that can be quickly removed or left partially open.

An anti-skating control is very necessary on any modern turntable. Friction between the stylus and the rotating disc draws the tone arm and cartridge toward the inner grooves. Without compensation, there is excessive inner groove wear, uneven stylus wear, and unbalanced stereo separation, as well as distortion.

The Thorens TD-166 and the Yamaha model both have a small counterweight on a plastic string. The Thorens allows for adjustment and different force applications; the Yamaha does not.

A variable-pitch control allows you to make very fine speed adjustments—usually about six to three percent. The Technics SL 1800 allowed as much as 10 percent. This control can be useful if you play along on a piano with a recording that's off pitch.

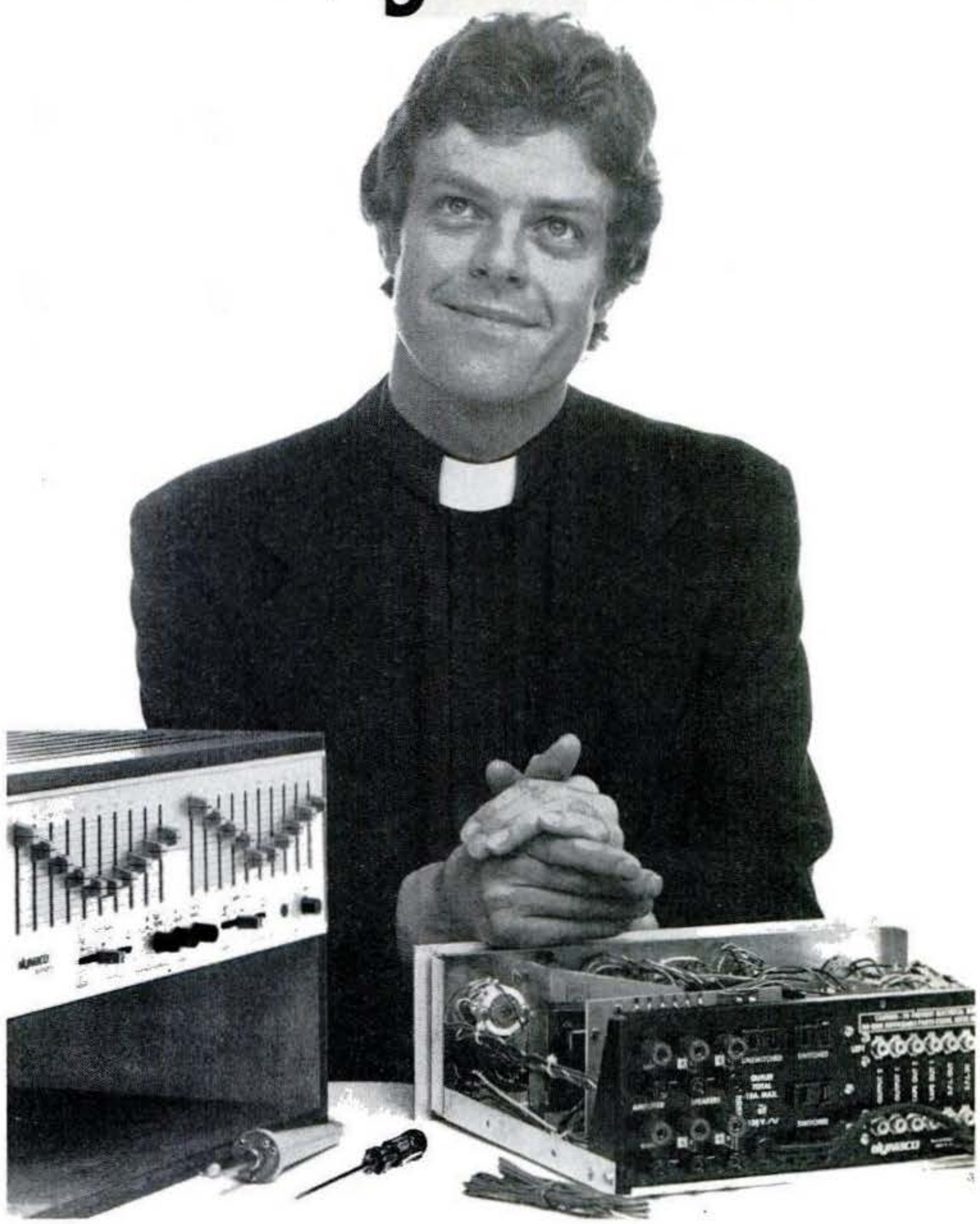
All the direct-drive turntables had platter markings and a strobe light that allows you to continuously monitor your turntable's speed. I found the strobe on the Garrard DD 75 hard to read. Some turntables such as the Philips GA 312 have strobe markings on the platter, but you must supply a lamp.

A manual turntable with automatic features usually costs more money. I believe a minimum automatic feature on any turntable is an auto-reject that prevents the stylus from grinding noisily away in the last grooves. The JVC JL-A40 had this feature. The Technics SL 1800 did not.

Many people can't place a cartridge on a disc gently or remove it with the delicacy of a good semi-automatic or fully automatic. A fully automatic goes beyond the semi-automatic in allowing you, with one press of a button or control, to place the stylus on the record without touching the arm.

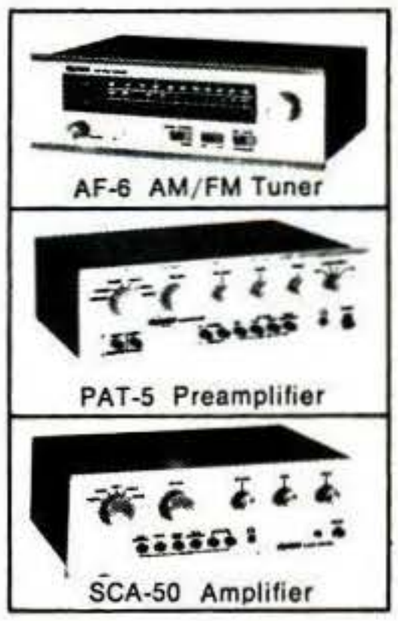
What should you buy? The more expensive machines generally have slightly better specifications and more convenience features. If you can afford them, they give good value for the money. An outstanding buy, if you negotiate the right price, is the Garrard DD 75, a direct-drive model with an automatic shutoff feature. I saw it advertised at $99 recently. I also thought the JVC JL-A40 was a standout. It has very attractive styling, lots of automatic features, and provides good performance. PS

Yes you can



build a dynakit.

Even 'churchmice' want the finest high fidelity, but when funds are scarce you take things into your own hands. We did and built Dynakits. It was surprisingly easy, the simple step-by-step instructions in their illustrated manual didn't let us go astray. A few evenings of my time and the church had a music system of the finest quality — and a saving of over $600. My only question—when 'work' is so much fun, is it sinful?



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Did you know that there are over a billion appliances in use in the United States today? And three repairmen. At least that's the way it seems when one of mine goes on the blink. With more than two dozen electrical gadgets in my house going snap, crackle and pop, I finally got tired of trying to locate a guy with enough ambition to take my money and I decided to learn how to make the repairs myself.

When a well-aged comic like me decides to go back to school, you can bet the family jewels it won't be back at P.S. 93. I'm going to learn at home, or not at all. So I sent away for NRI's home study course in Appliance Repair . . . and I took the course.

With a mechanical aptitude slightly below that of King Kong, I needed a course that started at the beginning and didn't move ahead too fast. Well, NRI did just that. They started with electricity—what it is and what it does —and went from there. You proceed at your own rate of speed. Whip through it if you want to, or take your time. What counts is the fact that you learn, in a way that it sticks with you.

You learn two things: how to repair appliances—from little one cylinder gas engines to refrigeration and air conditioning equipment; and how to get started in your own appliance business. That can mean money for you either way. If NRI can turn old ten thumbs Morgan into a reasonable facsimile of a repairman, think what they could do for you!

NRI's no fly-by-night outfit. They've been training men for more than sixty years . . . and they've had over a million students. It's the oldest and largest home study school in the field of electronics and electricity, so they know it better than anyone else around.

The NRI course is really easy to understand . . . with lots of pictures to show you what they're talking about. They even send you a professional appliance tester at no extra cost.

With the tester and a few basic tools you probably have already, you're ready to service most electrical appliances. After a few months, you'll be fixing your own appliances like I do, or you can start earning spare time money fixing them for your friends and neighbors. Before you know it, you can have your own full-time business and be independent.

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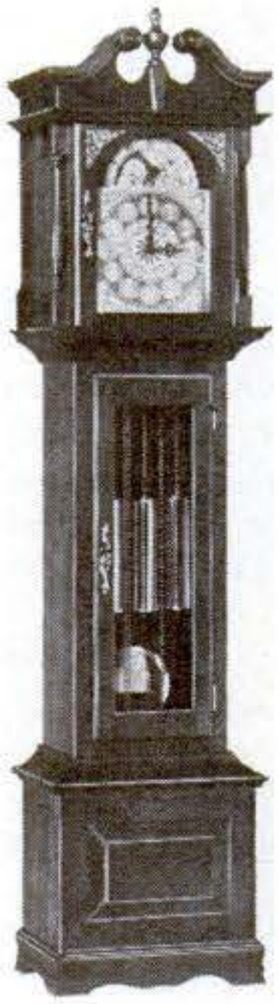

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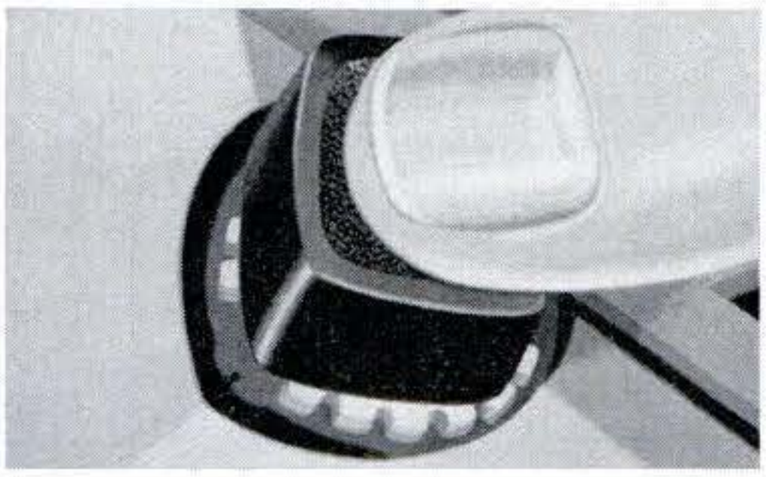

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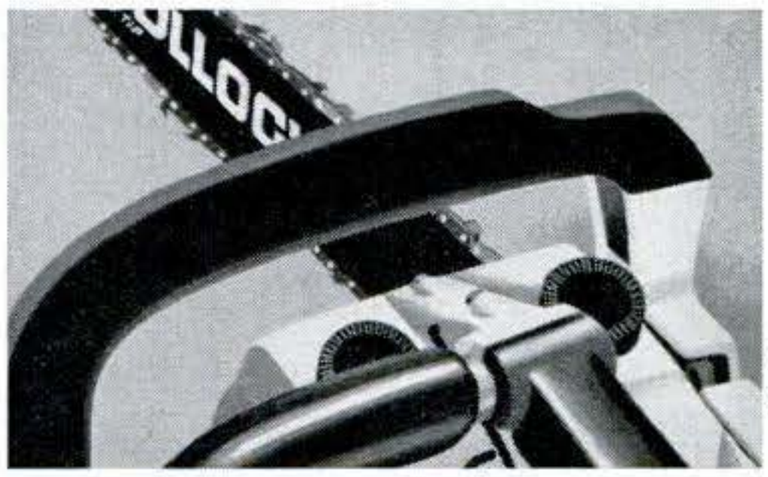

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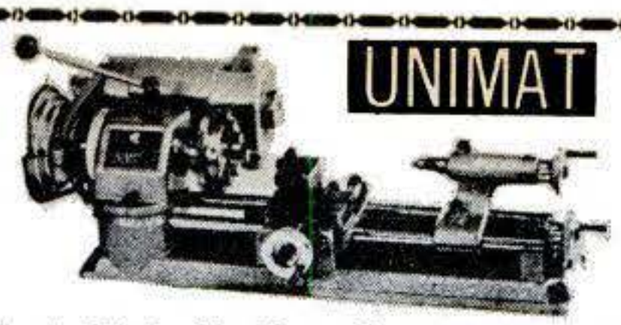

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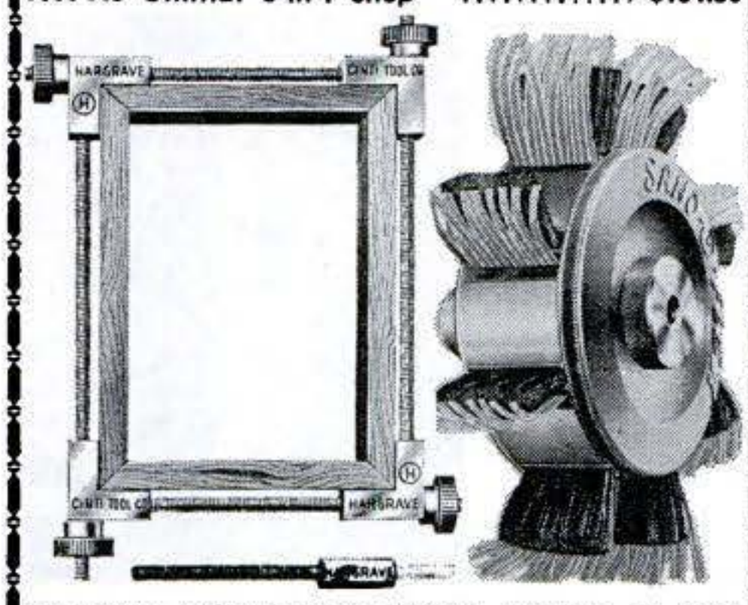

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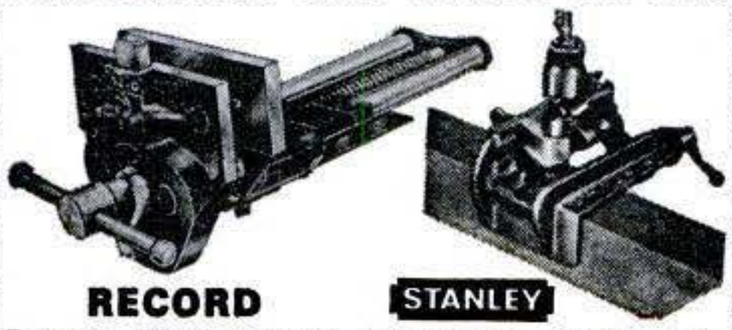

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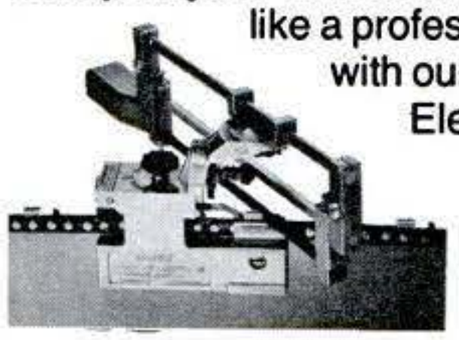

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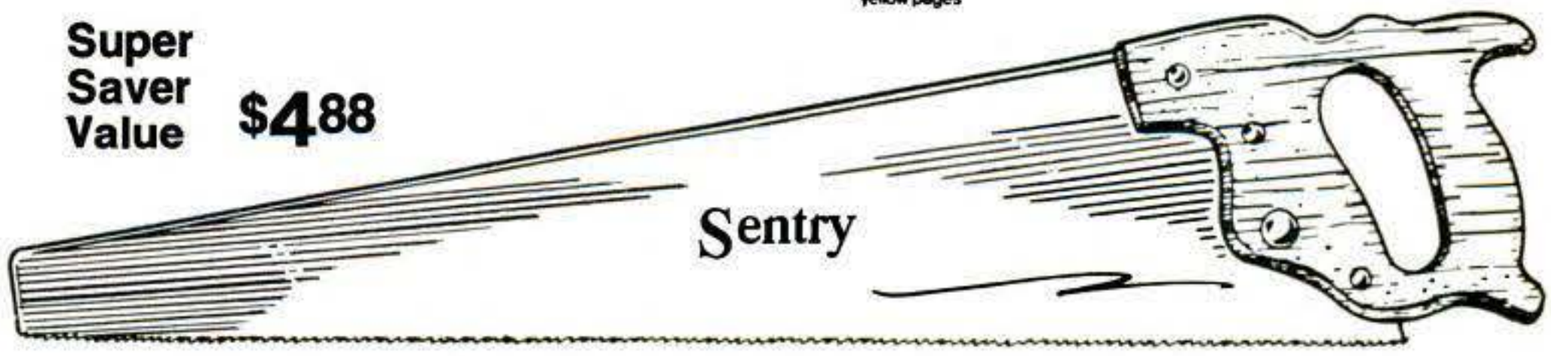

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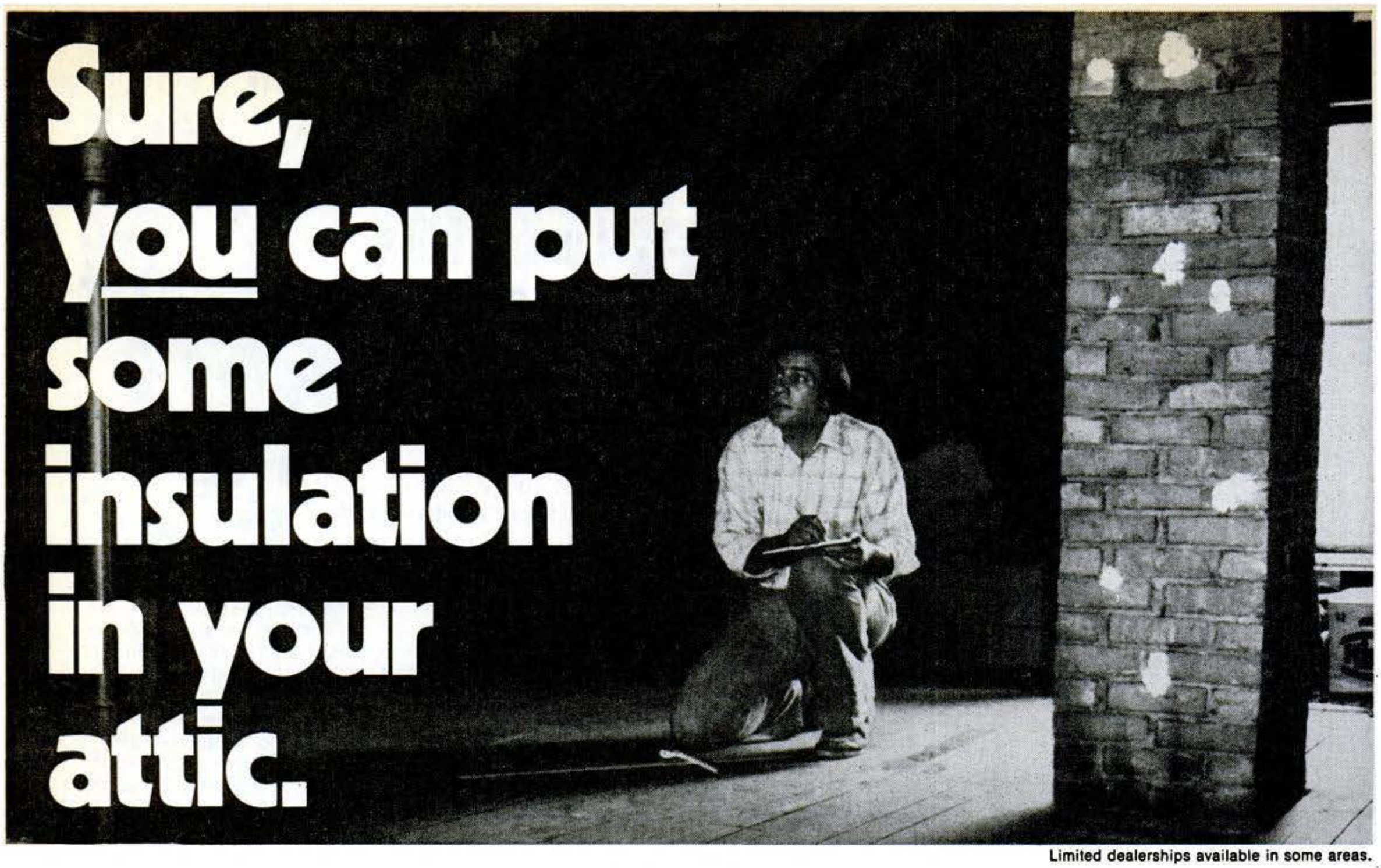

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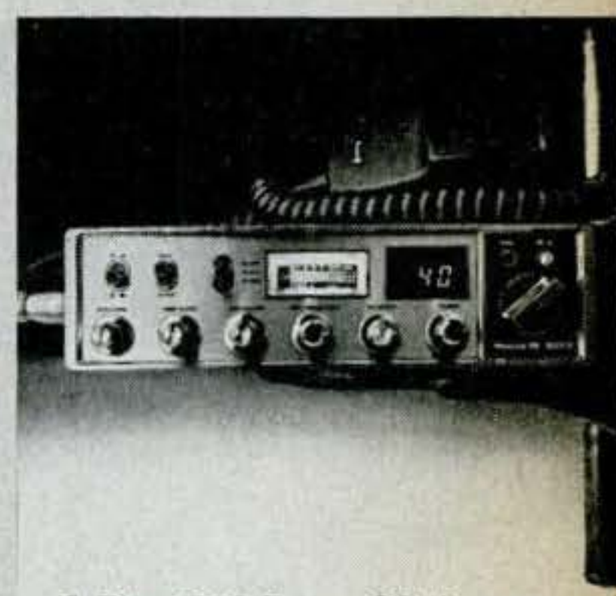

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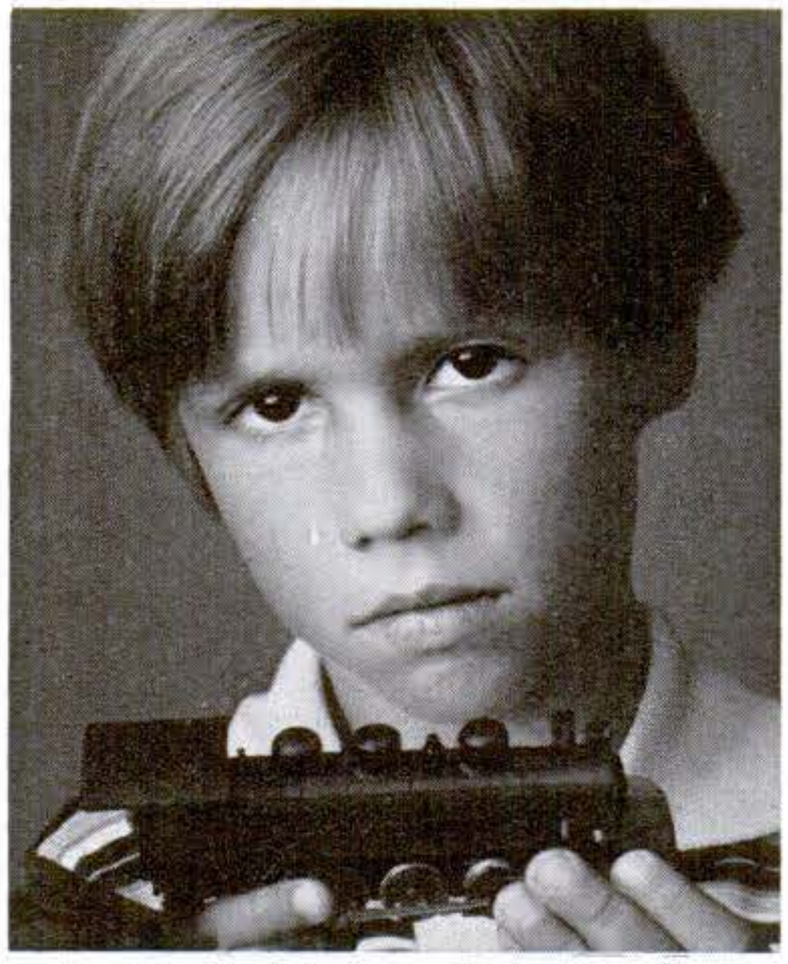

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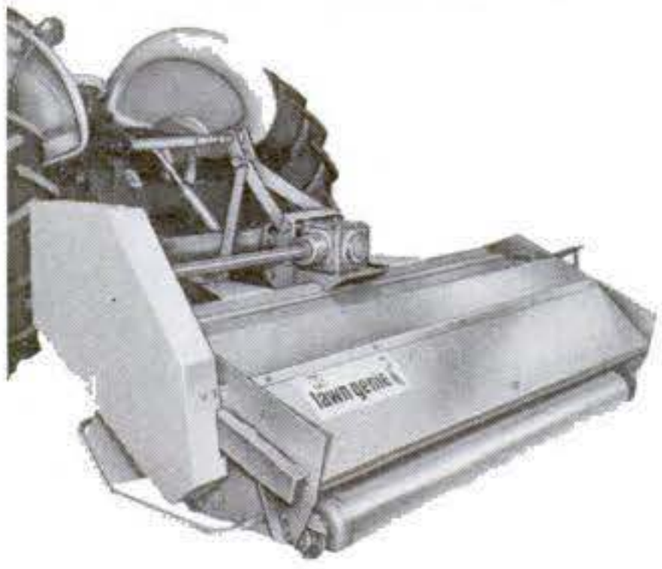

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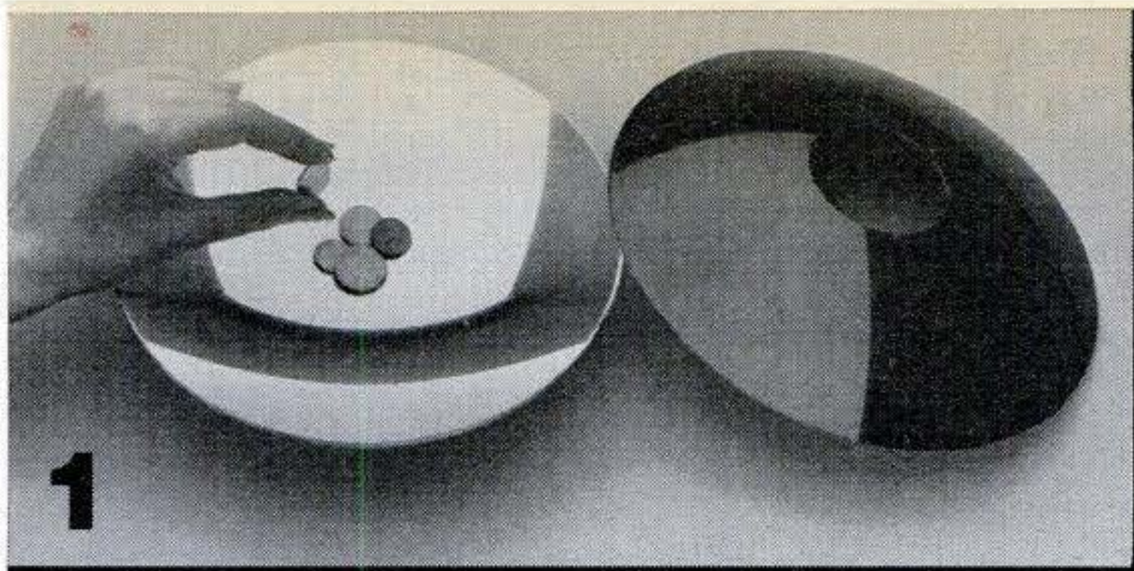
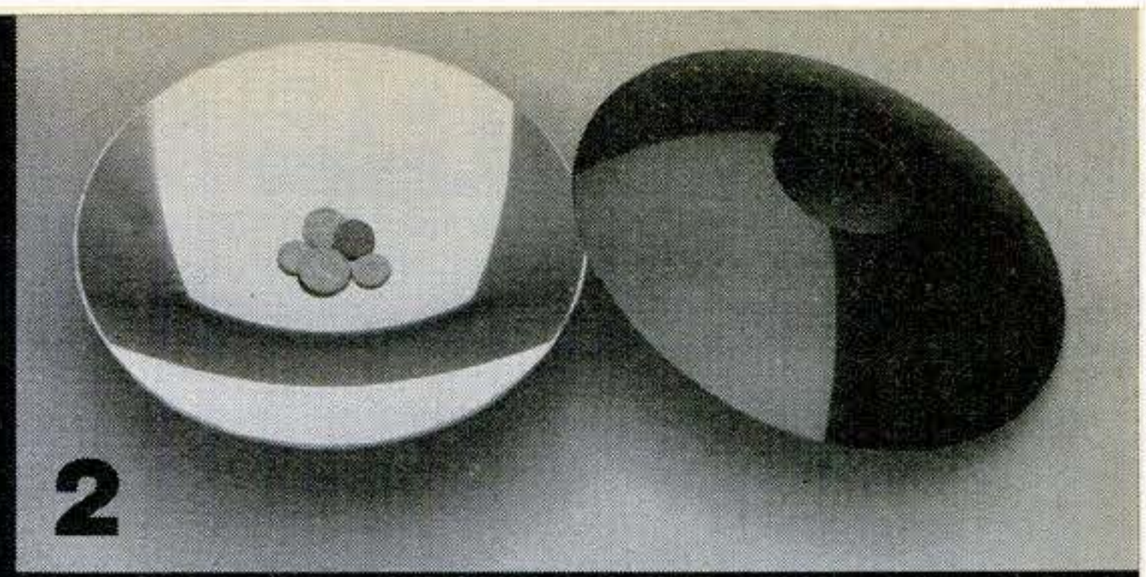
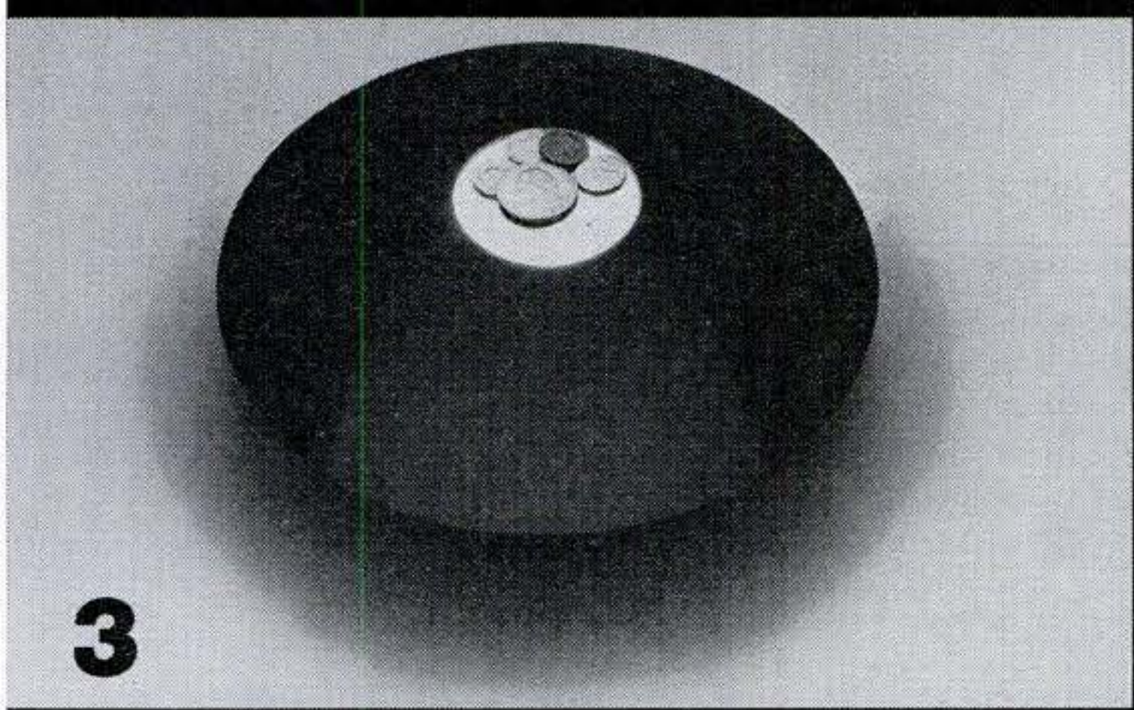


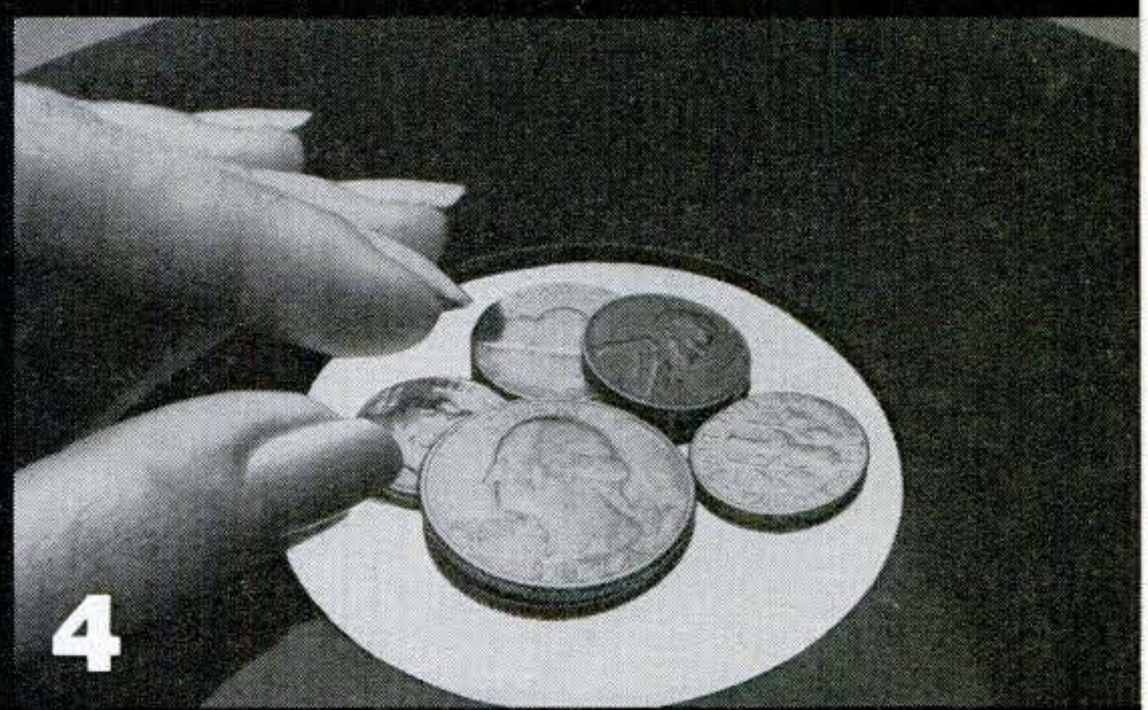
You'll baffle and bewilder everyone with these deceptive mirages. Simply place any small object into the base element.



If you wish, use several small items. For this effect—out of hundreds of choices—a handful of coins is selected.



Replace top element. Instantly, magically, the coins appear to JUMP to the circle on top, clearly visible in full 3-DIMENSION. For sure, the coins are so realistic you can even see their reflection. (For sure?...actually, this mirage is "floating" in thin air!)



Study the mirage. Look at it from all sides. Listen to it. Smell it. Shine a light on it. Even photograph it—the coins are really there. *Yet reach to pick them up, your fingers go right through.* There's nothing there at all!

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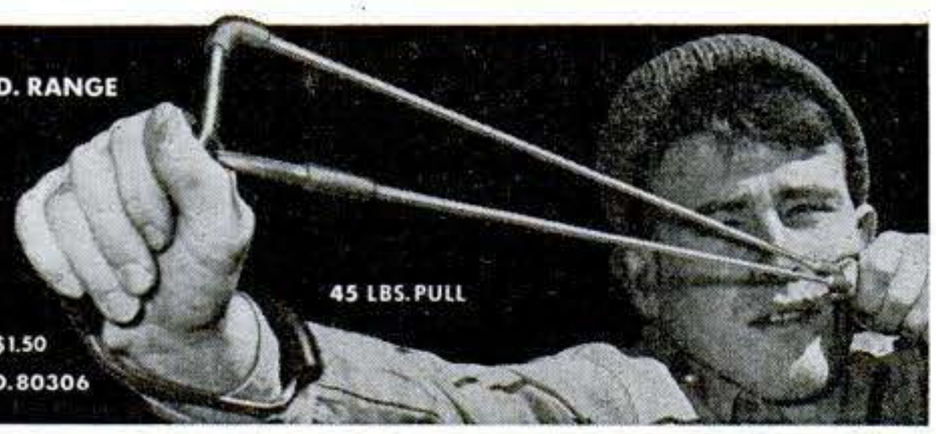

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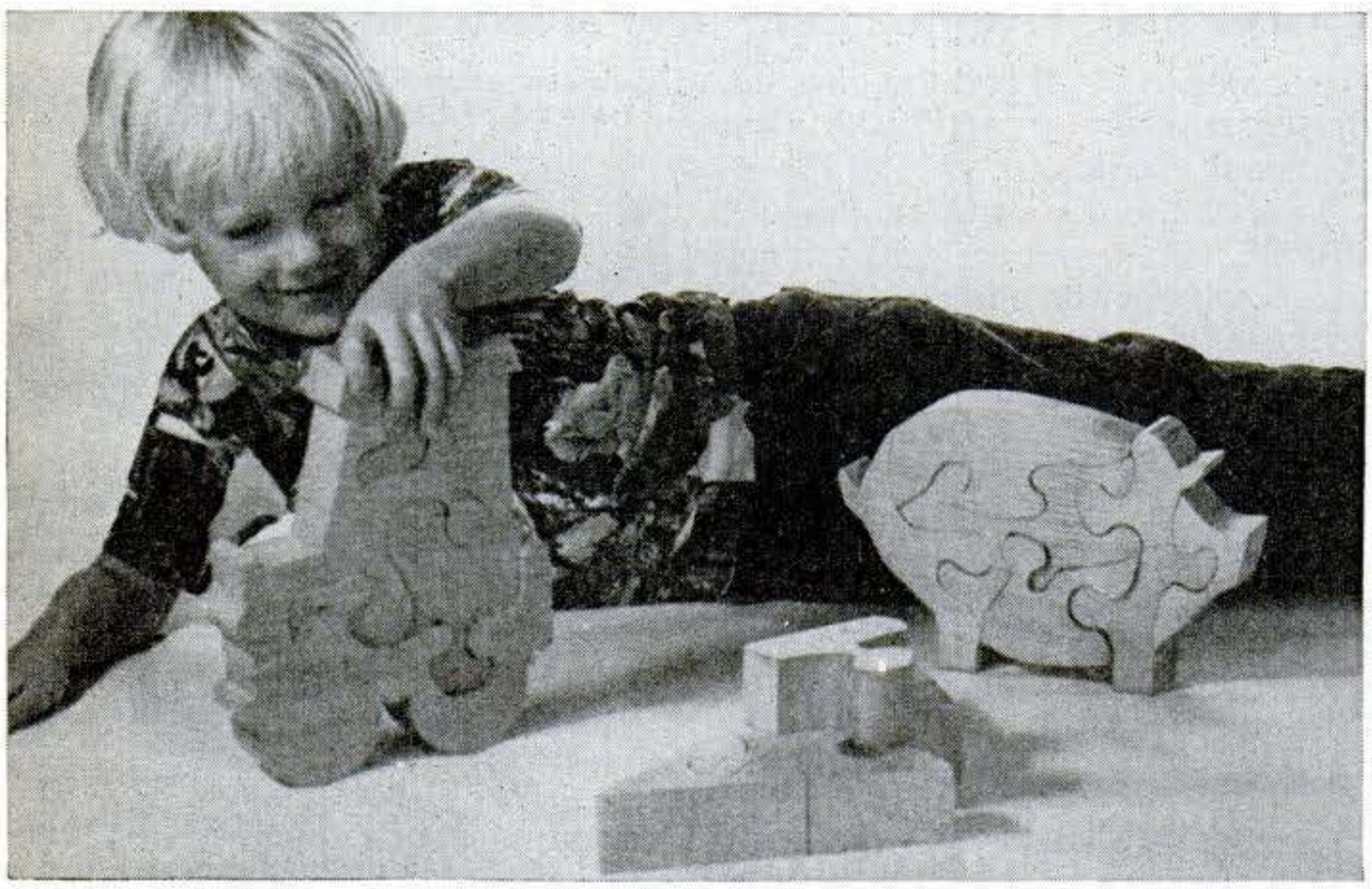

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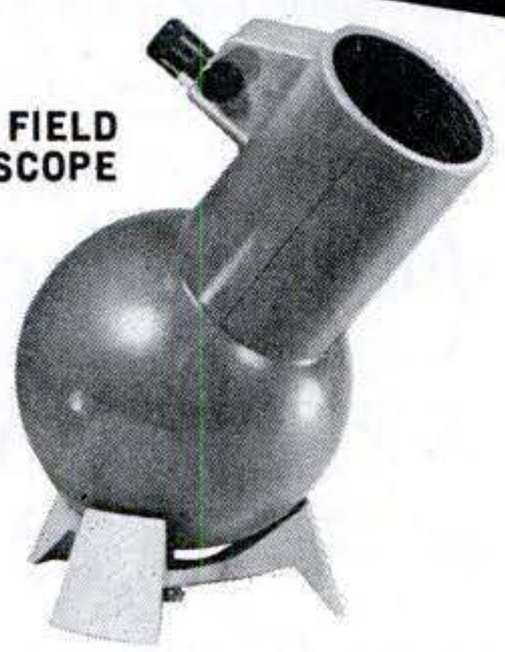

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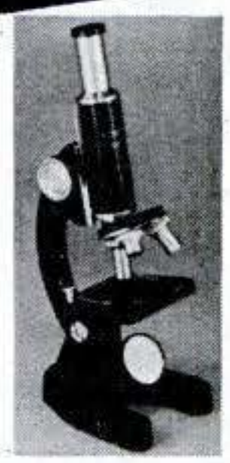

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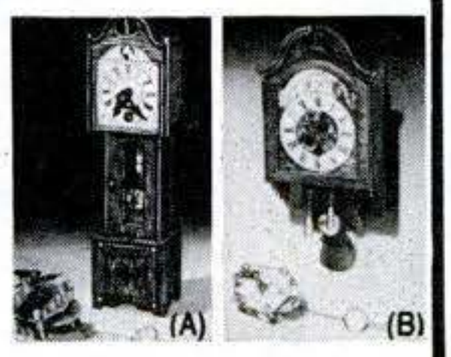

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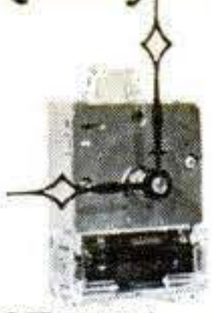

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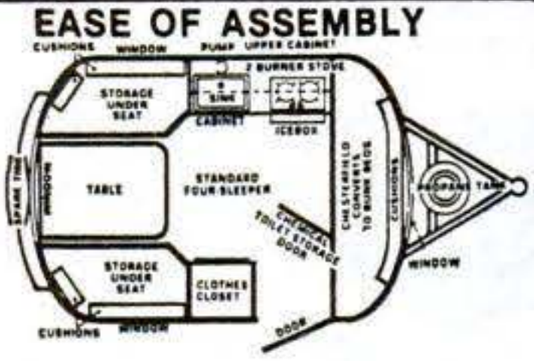

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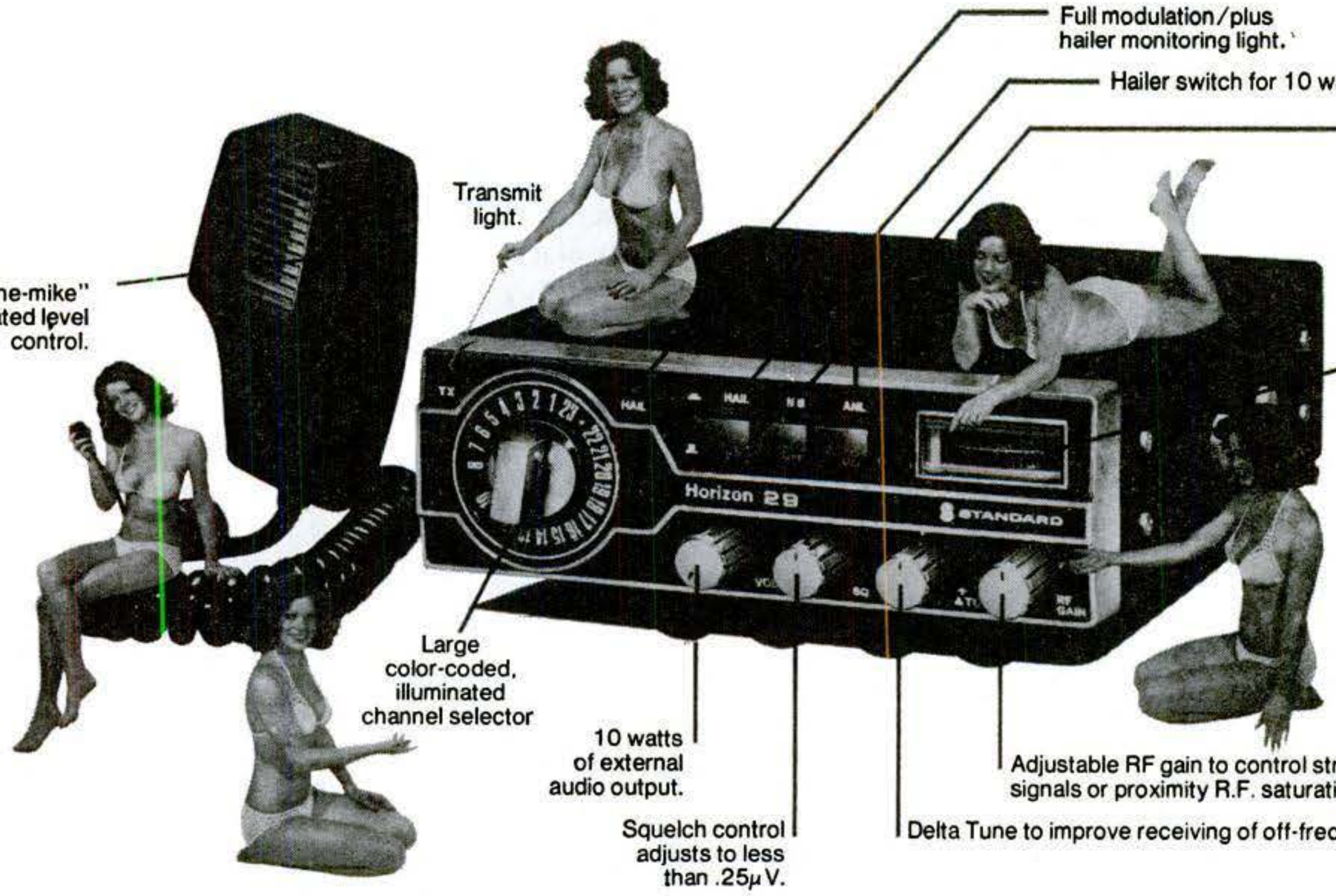

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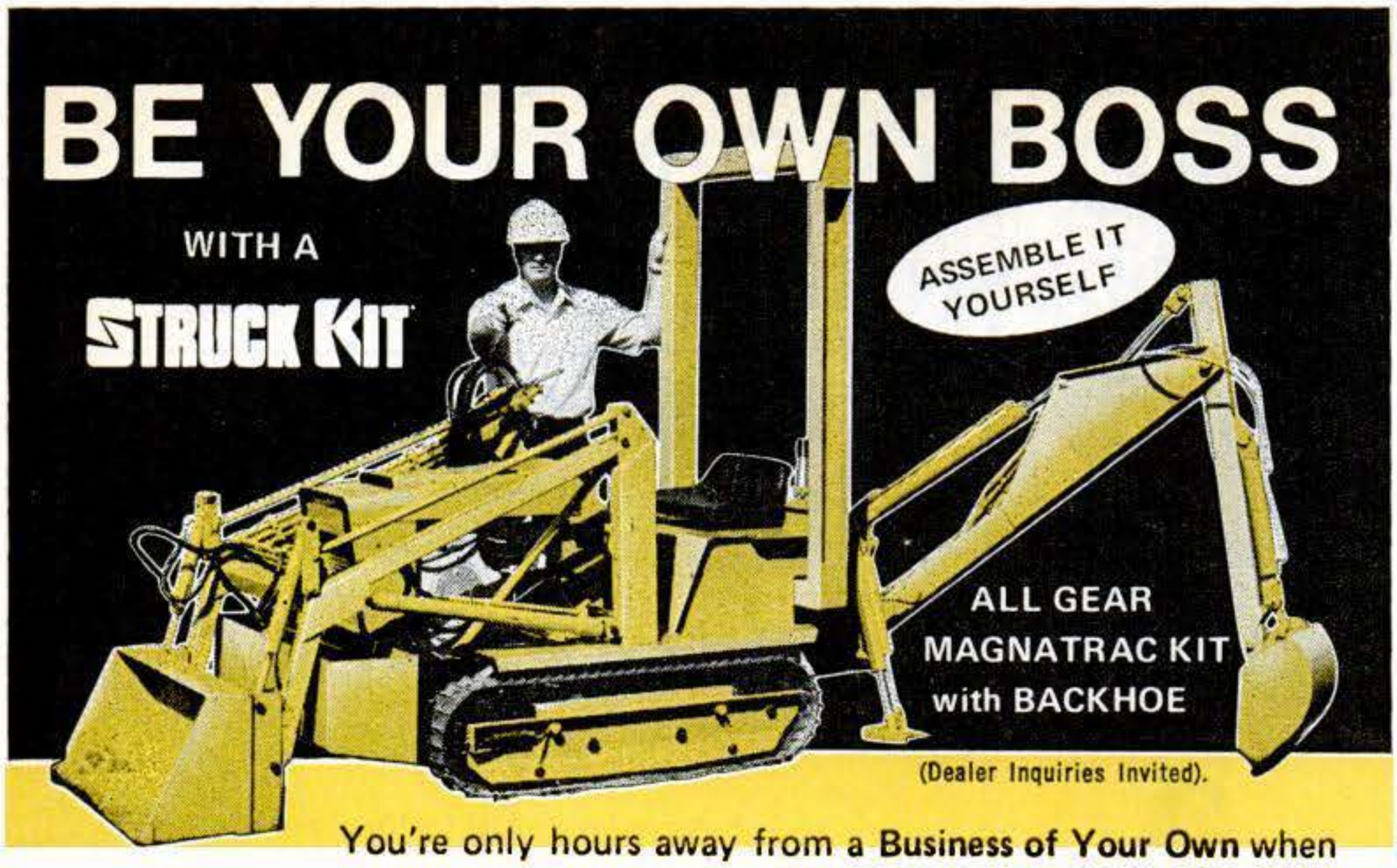

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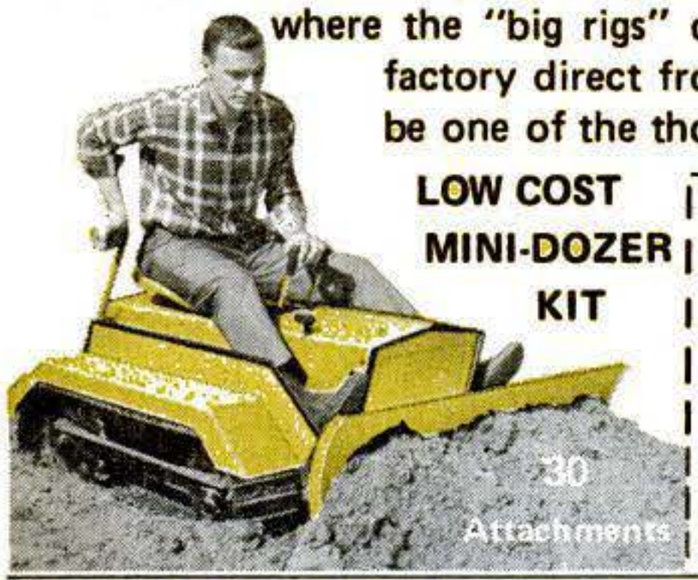

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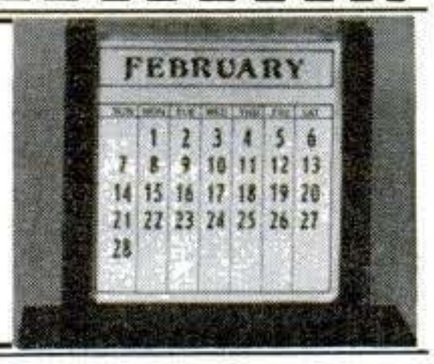

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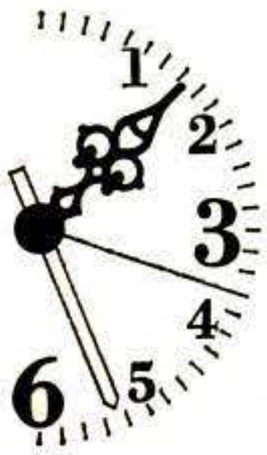

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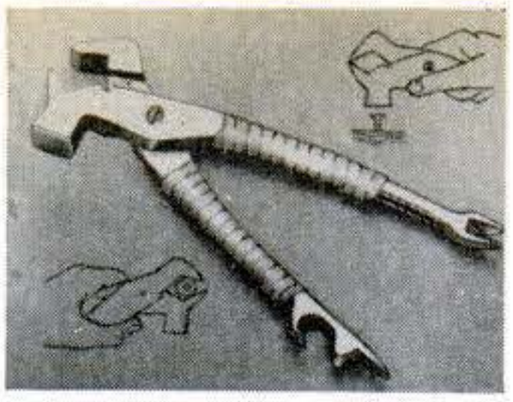

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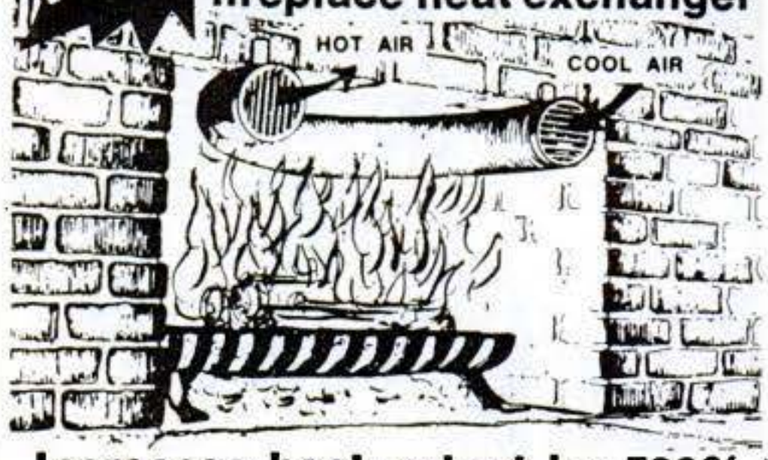

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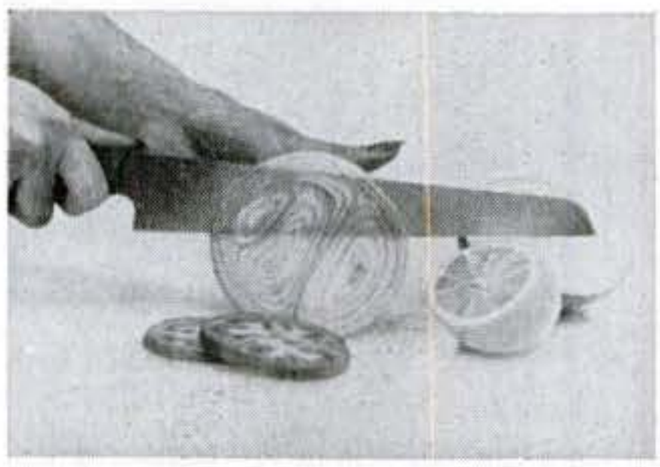

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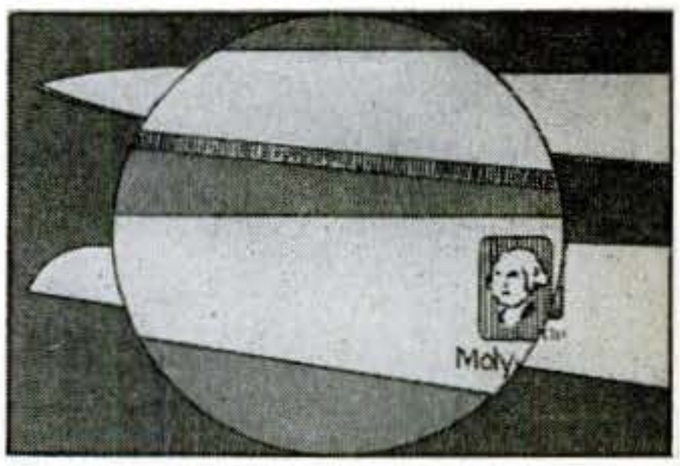

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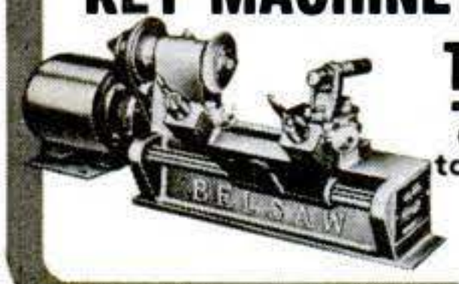

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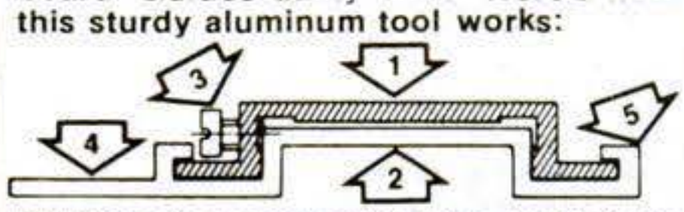

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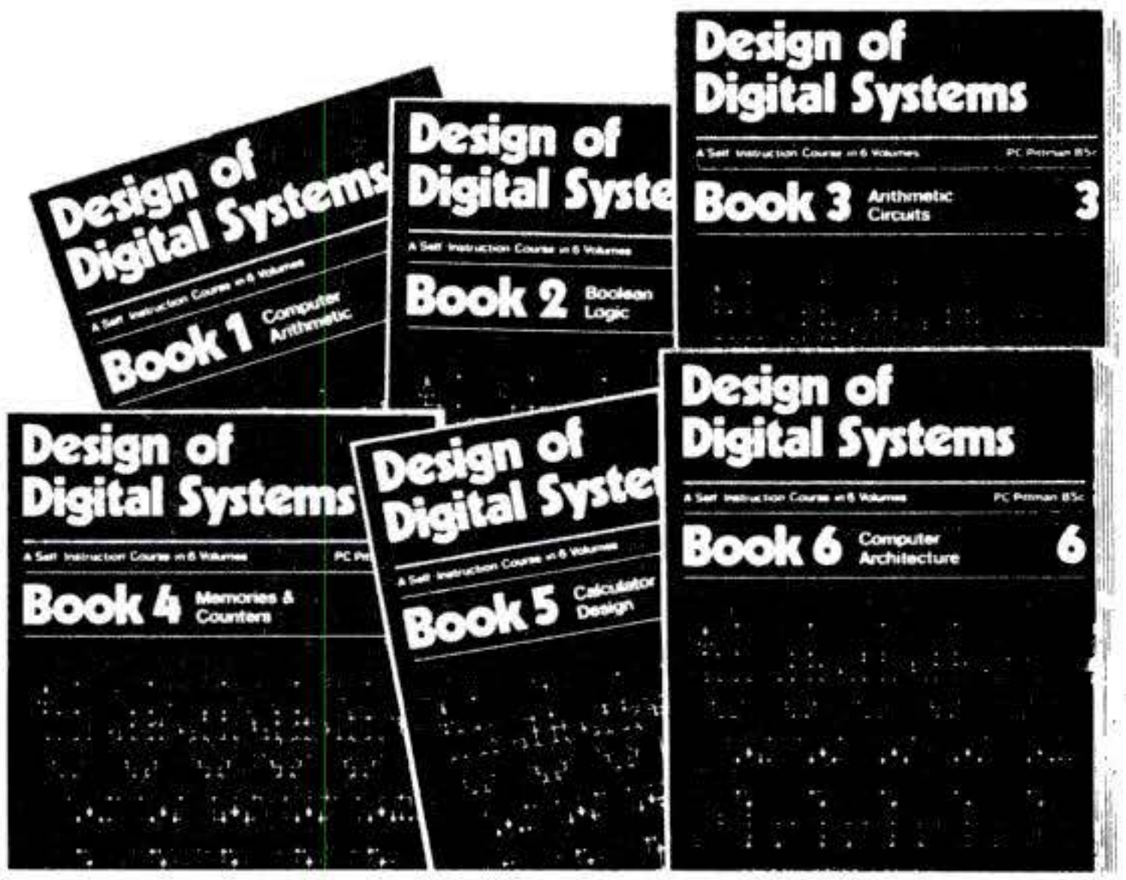

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Book 2 OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.

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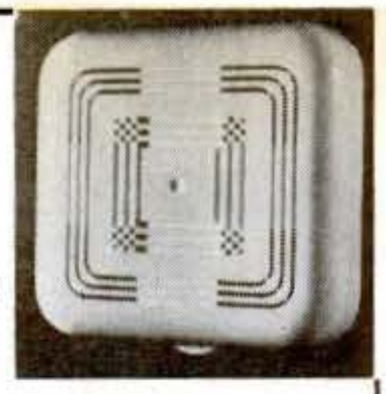

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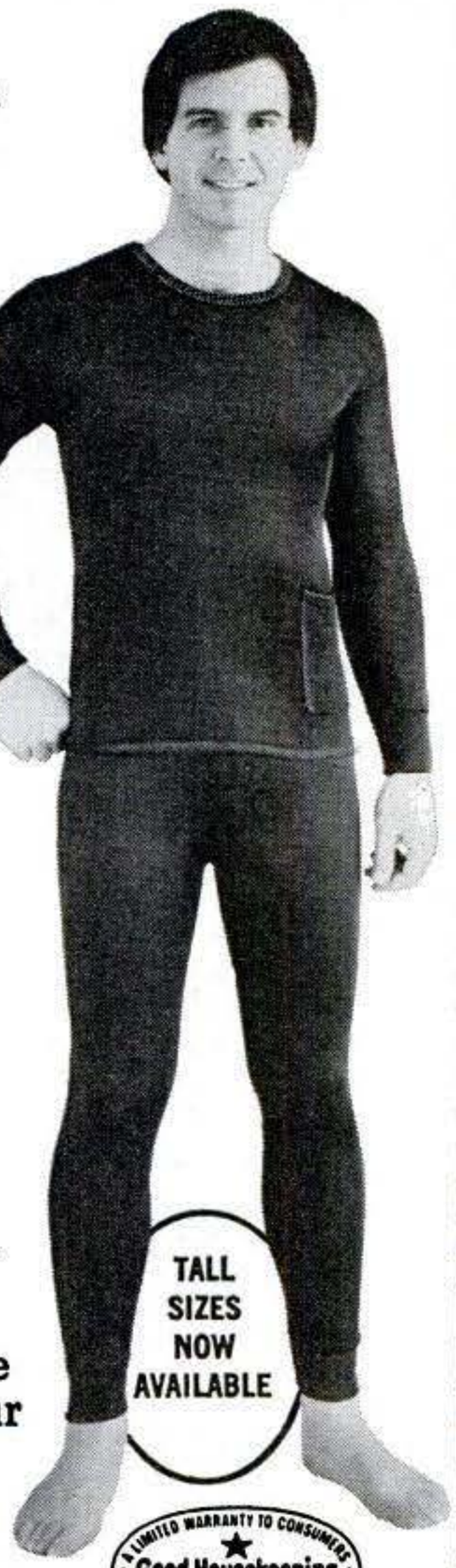

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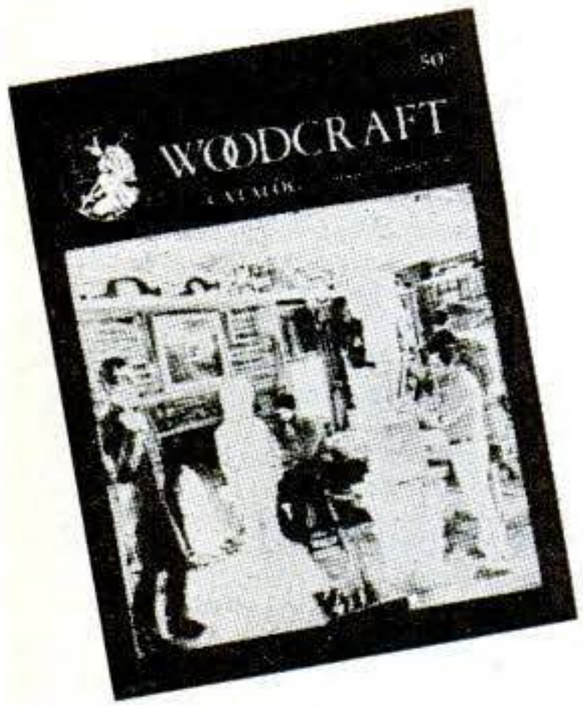

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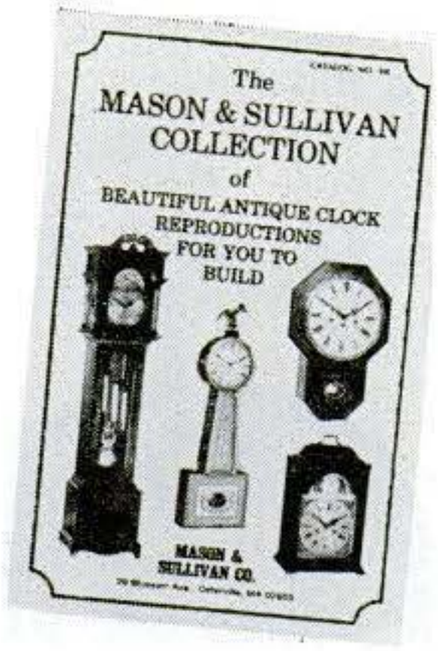

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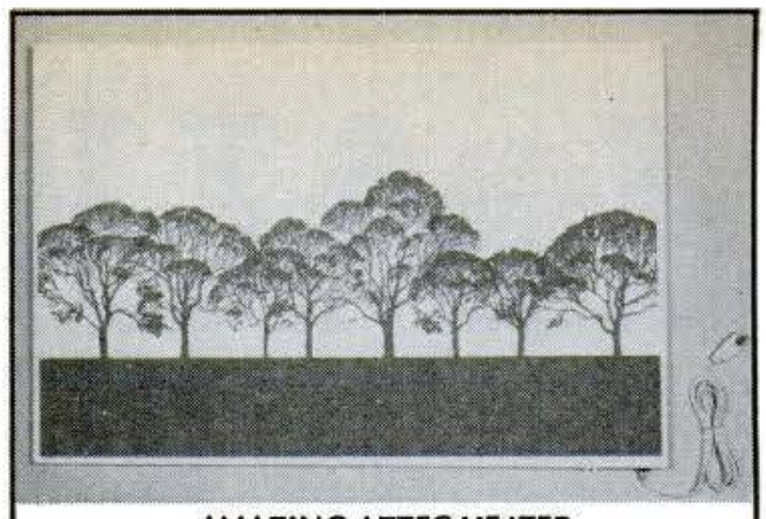

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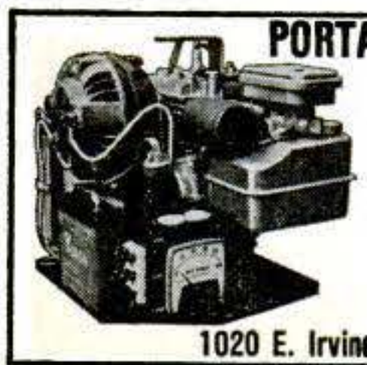

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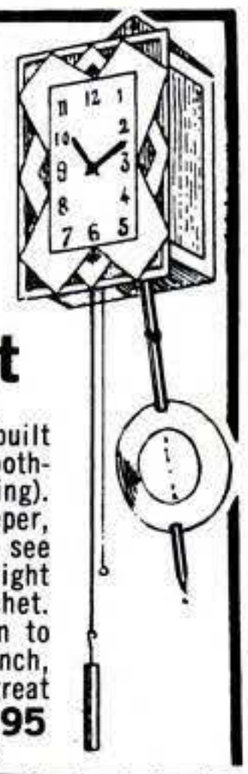

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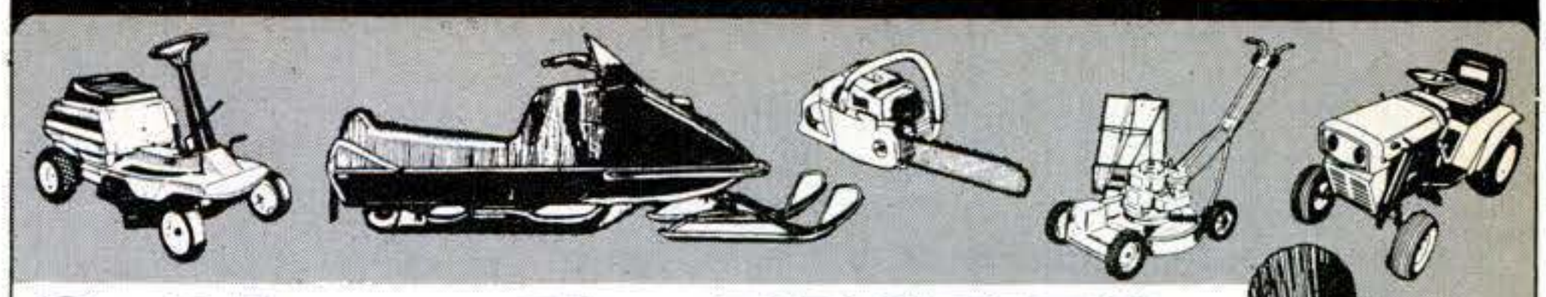

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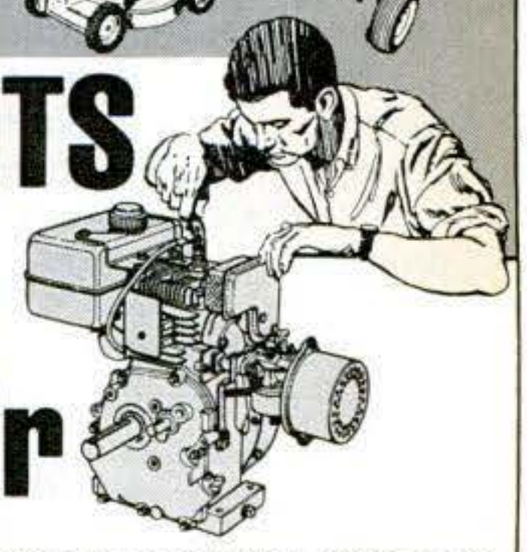

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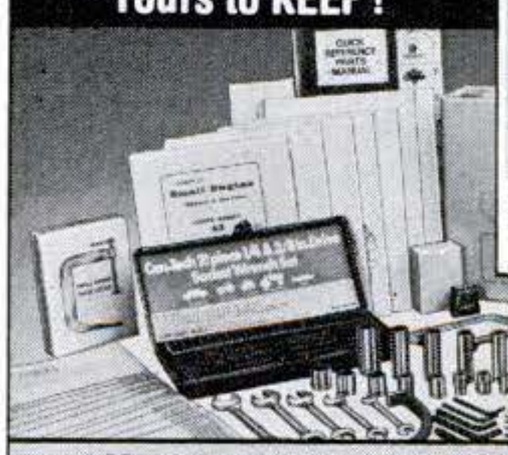

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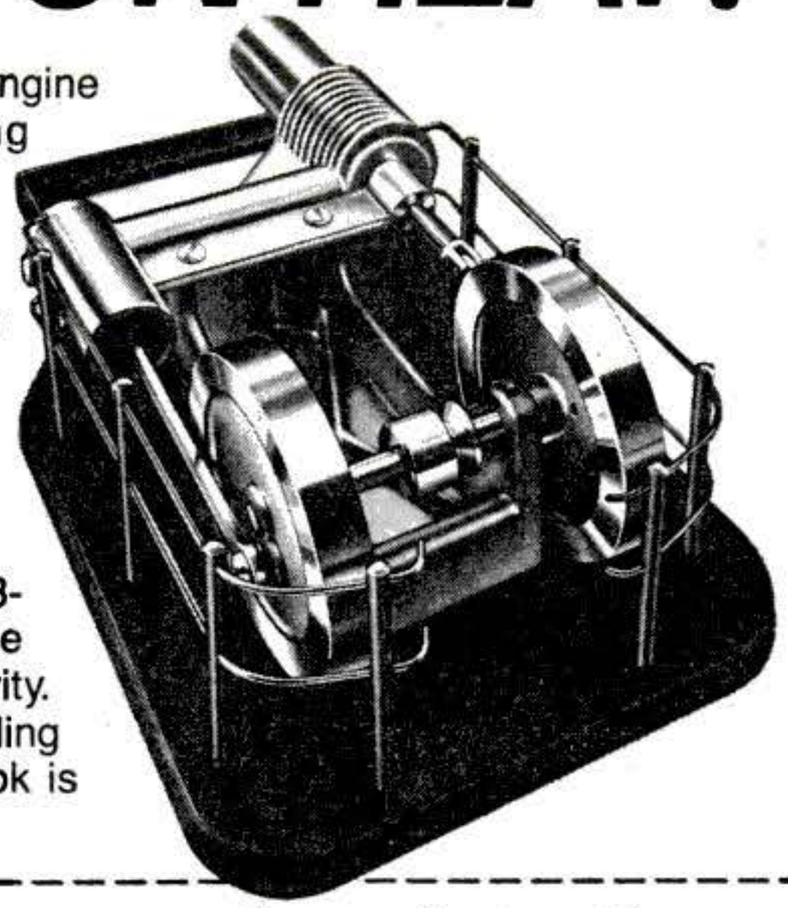

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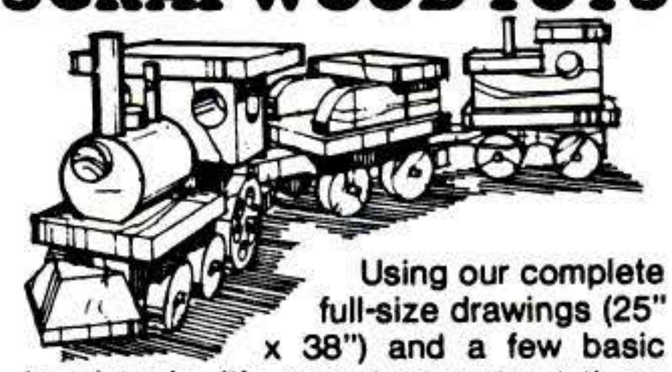

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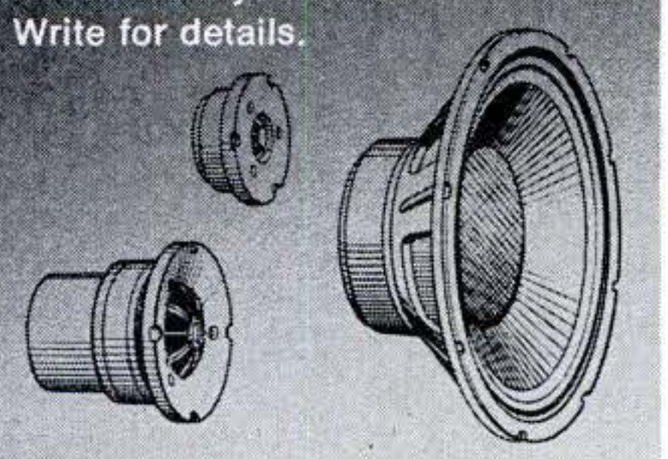

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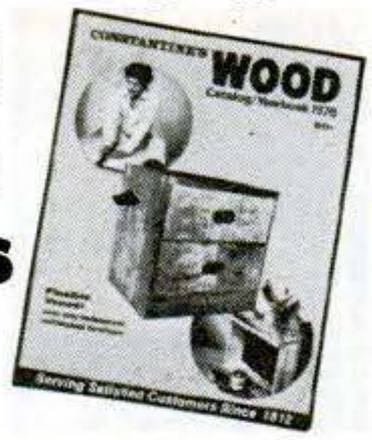

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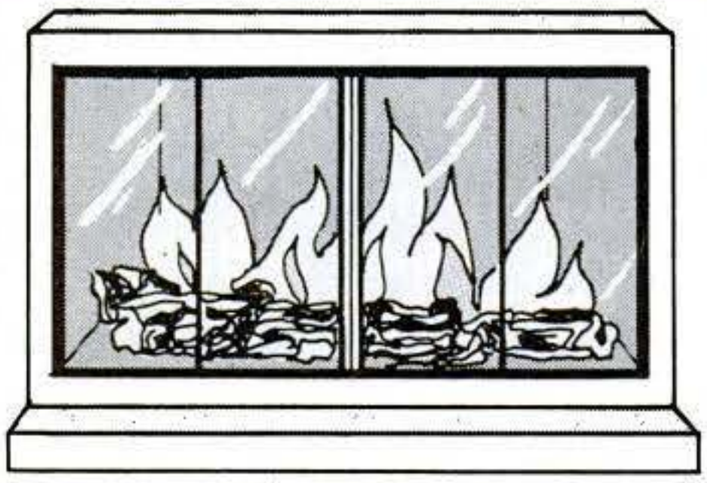

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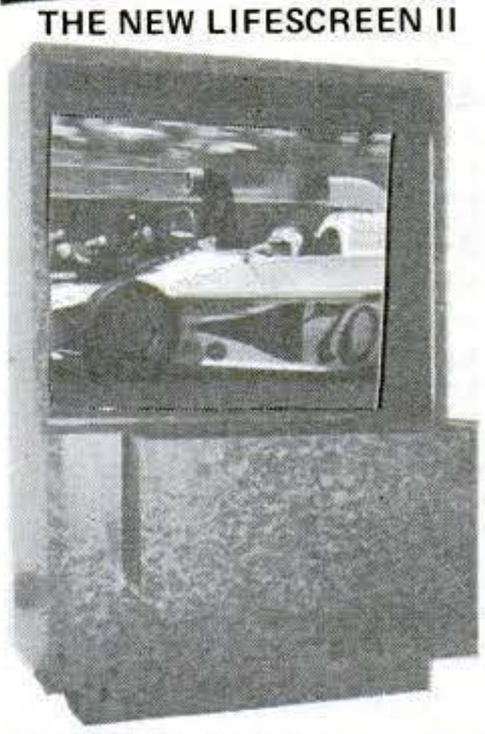
THE NEW LIFESCREEN II



WE HAVE RECEIVED THOUSANDS OF INQUIRIES!
YOU REQUESTED PLANS FOR A BIG SCREEN TV THAT WOULD:
utilize any portable TV as an image source — require a minimum of floor space —be a beautiful piece of furniture.

NOW – EXTRON IS HAPPY TO ANNOUNCE THE NEW LIFESCREEN II

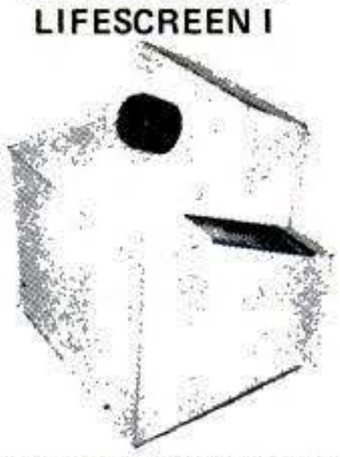
The LIFESCREEN was designed for the Do-It-Yourself enthusiast who wishes to have the enjoyment and excitement of a professional Big Screen TV – but refuses to pay the $1500 to $4000 that most manufacturers charge for this luxury.

FACTS

The special LIFESCREEN, Lens and Front Surface mirror supplied by Extron are the same type used by major Big Screen TV manufacturers (Sony, Muntz, etc.). THESE PROFESSIONAL COMPONENTS SHOULD NOT BE CONFUSED WITH THE CHEAP PLASTIC MAGNIFYING IMITATIONS NOW FLOODING THE MARKET BECAUSE OF THE POPULARITY OF BIG SCREEN TV.

The EXTRON TV Screen – the same used by the major Big Screen TV manufacturers – is 16 TIMES BRIGHTER than a flat matte surface and 6 TIMES BRIGHTER than most flat beaded movie screens. Its parabolic shape rejects extraneous light, concentrating a highly efficient and directionally selective television image that is exceptionally sharp and colorful.

THE ORIGINAL LIFESCREEN I



COMPLETE LIFESCREEN II PACKAGE: **$299**

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TAKES 10 to 15 HOURS TO BUILD
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COMPONENT LIST
1 set of LIFESCREEN II Plans
1 Portable transistor Color TV (12" to 19")
1 LIFESCREEN Lens
2 LIFESCREEN Front Surface Mirrors: one 8"x10" and one 14¾" x 20".
1 EXTRON LS 50 Screen, 32"x40"/50" Diag.

THE EVERYTHING GUARANTEE
EXTRON GUARANTEES EVERYTHING: THE PROFESSIONAL QUALITY, ACCURACY OF DESCRIPTION, AVAILABILITY AND PROMPT DELIVERY OF COMPONENTS DESCRIBED IN THIS AD. If, after building your LIFESCREEN PROJECTION SYSTEM, you are not satisfied for any reason, return all components to EXTRON, 8831 Sunset Boulevard, West Hollywood, California for instant refund of the purchase price.

COMPONENT LIST
1 set of LIFESCREEN I Plans
1 Sharp 13" Model 13A21 Color TV or Sony 15" Model KV 1541R Color TV.
1 LIFESCREEN Lens
1 LIFESCREEN Front Surface Mirror, 8" x 10"
1 EXTRON LS 50 Screen 32"x40"/50" Diagonal.

LARGER SCREENS can be ordered through EXTRON (67" or 80" Diag.)

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☐ EXTRON LS 50 SCREEN 32" x 40"/50" Diagonal ..... @ $90.00
☐ **COMPLETE LIFESCREEN I PACKAGE ..... @ $269.00**
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*To substitute Tron-Ex Lens, add $75.00 to package price
All prices F.O.B. factory—Cal. residents add 6% sales tax TOTAL: $ _____

EXTRON LIFESCREEN® PROJECTION SYSTEM
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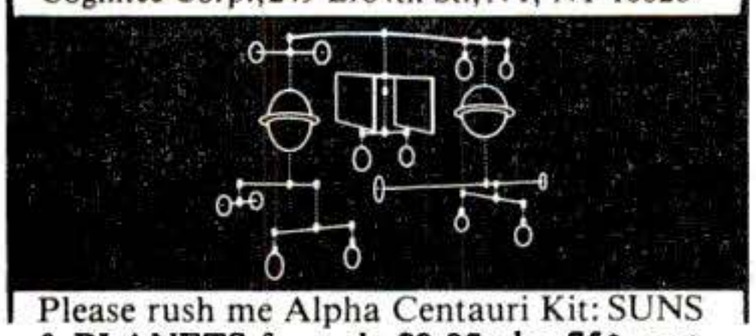

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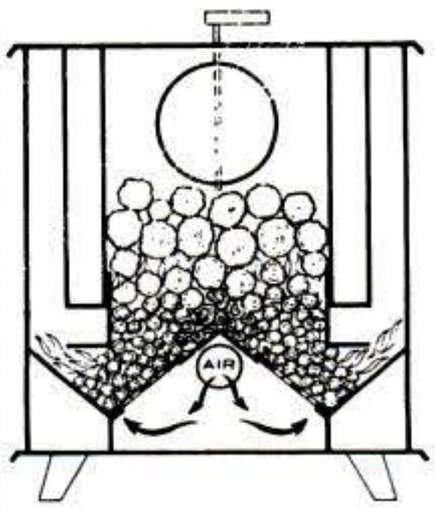

Write for details plus reprint from October 1976 **Popular Science** "Wood as Fuel—The Science of Woodburning". Include 50¢ for **"Buyers Guide to Woodstoves".**

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Vermont Woodstove Co.
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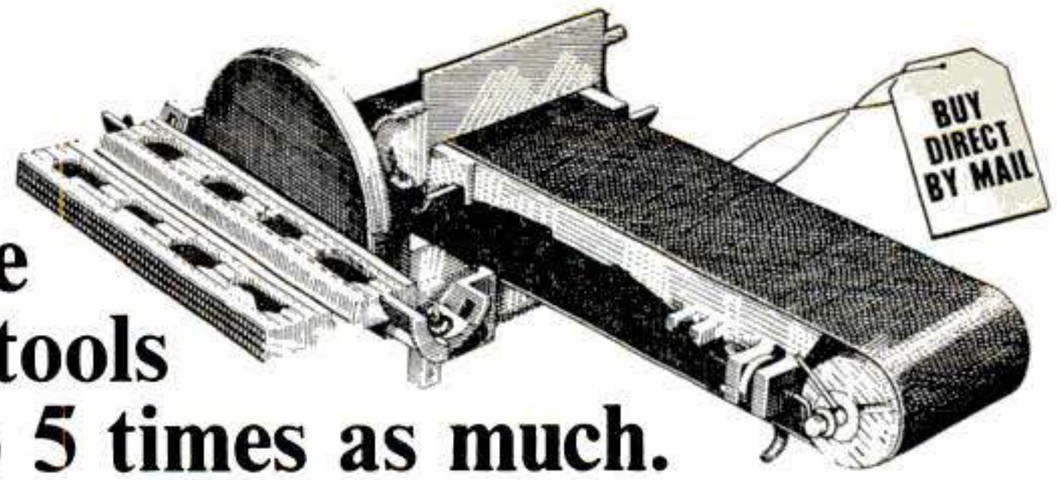

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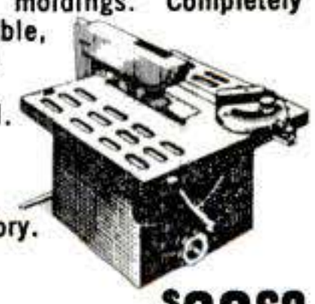

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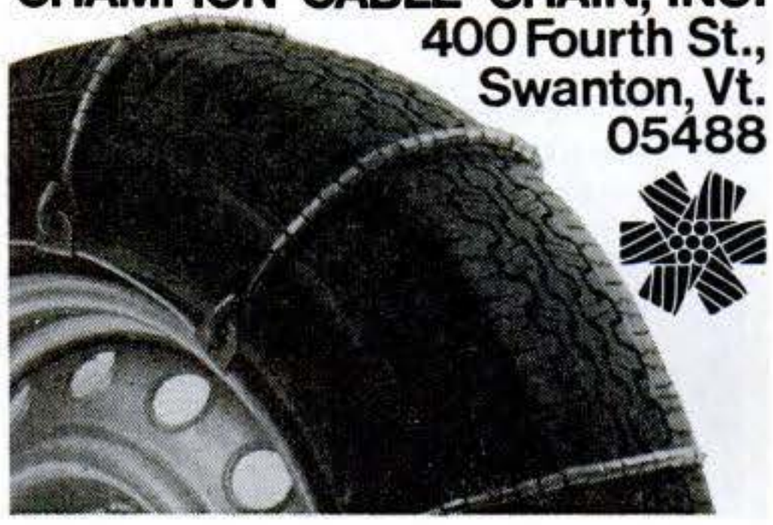

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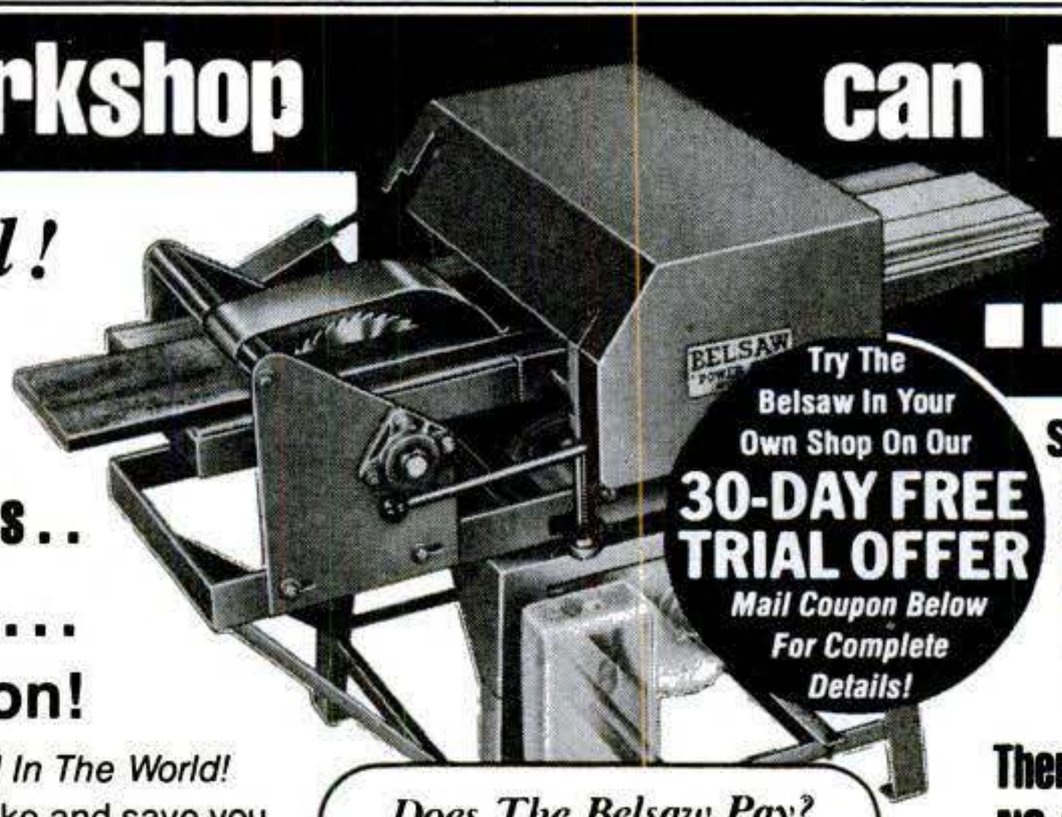

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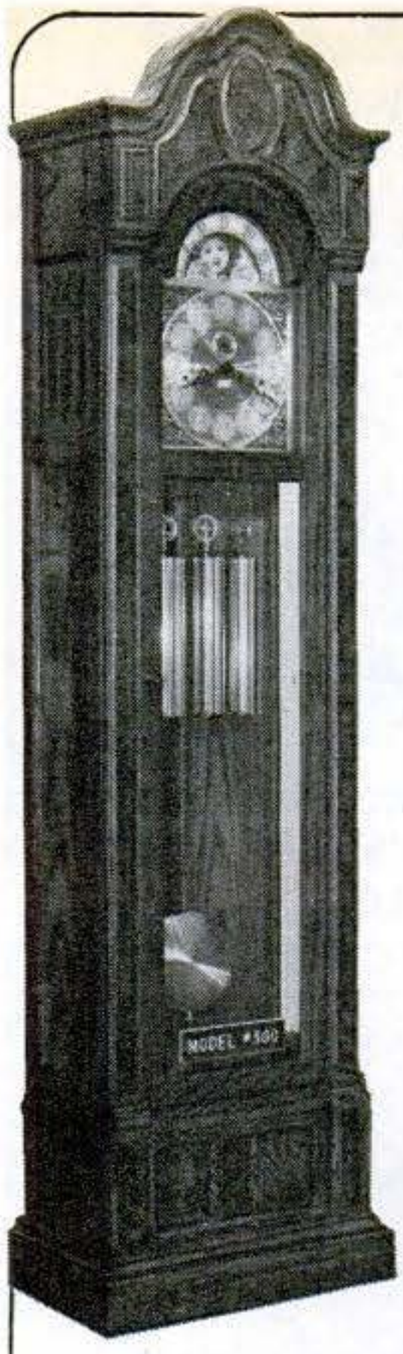

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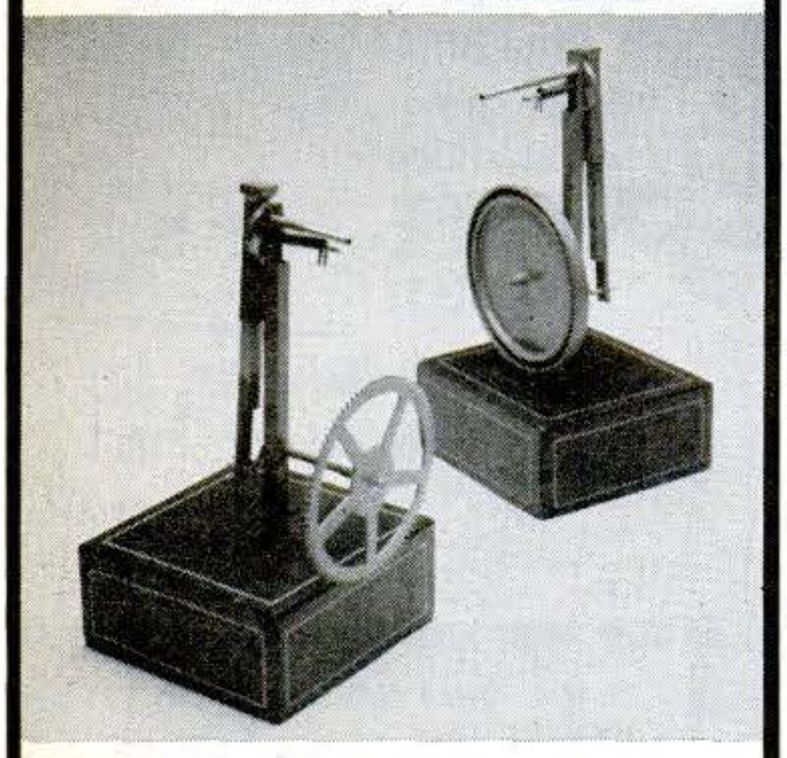

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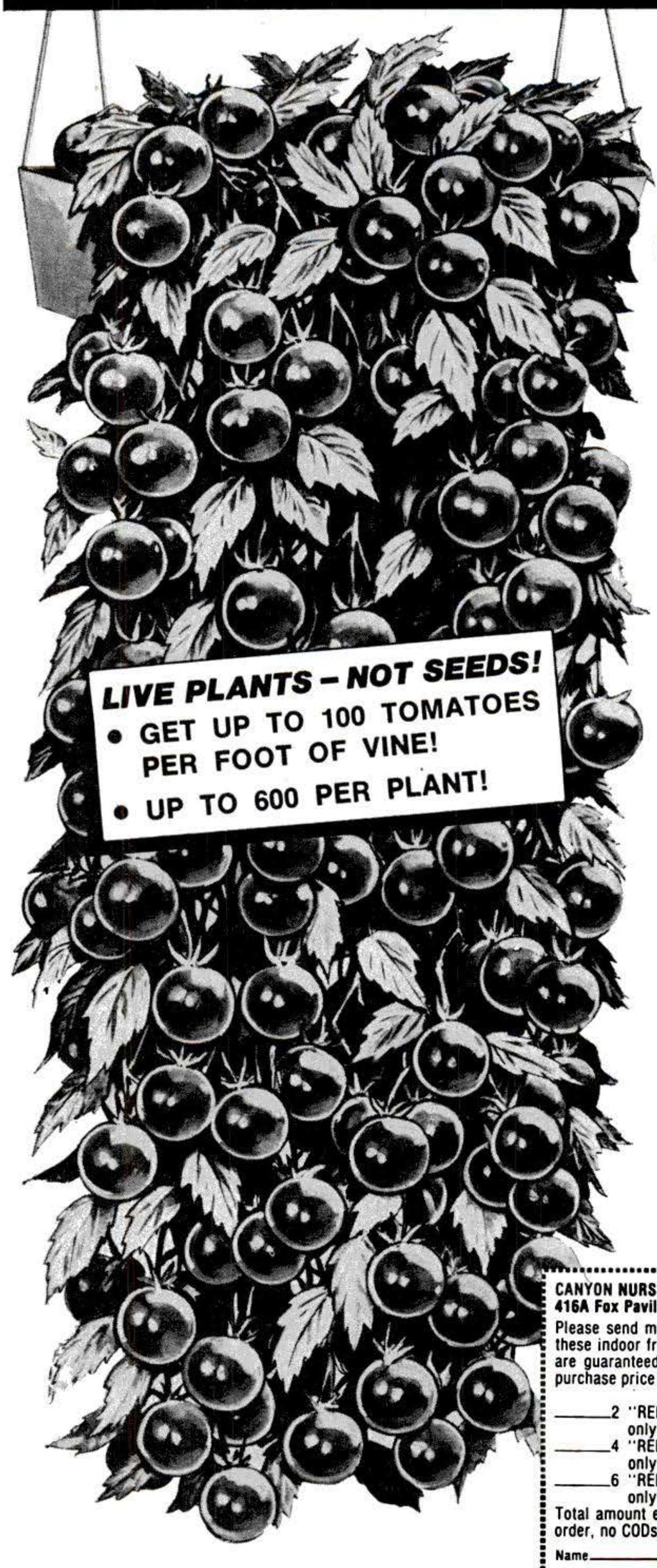

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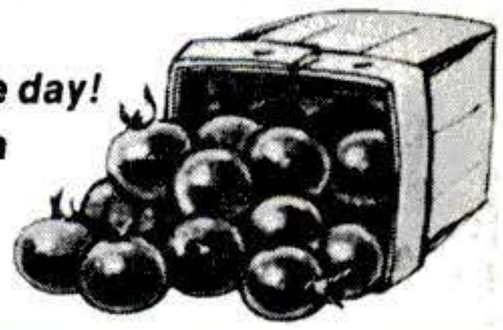

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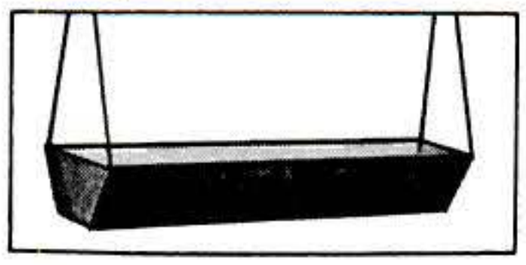

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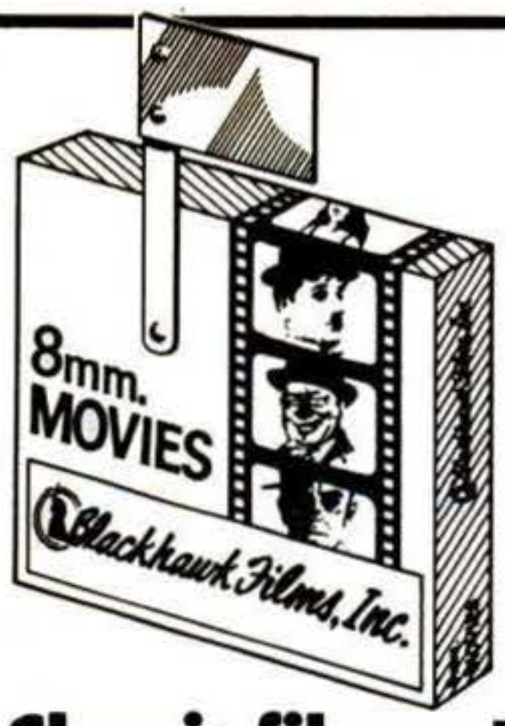

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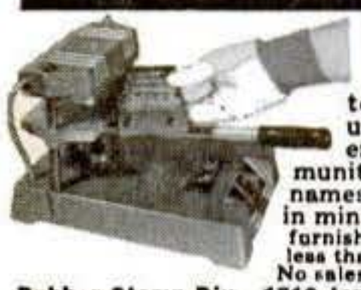

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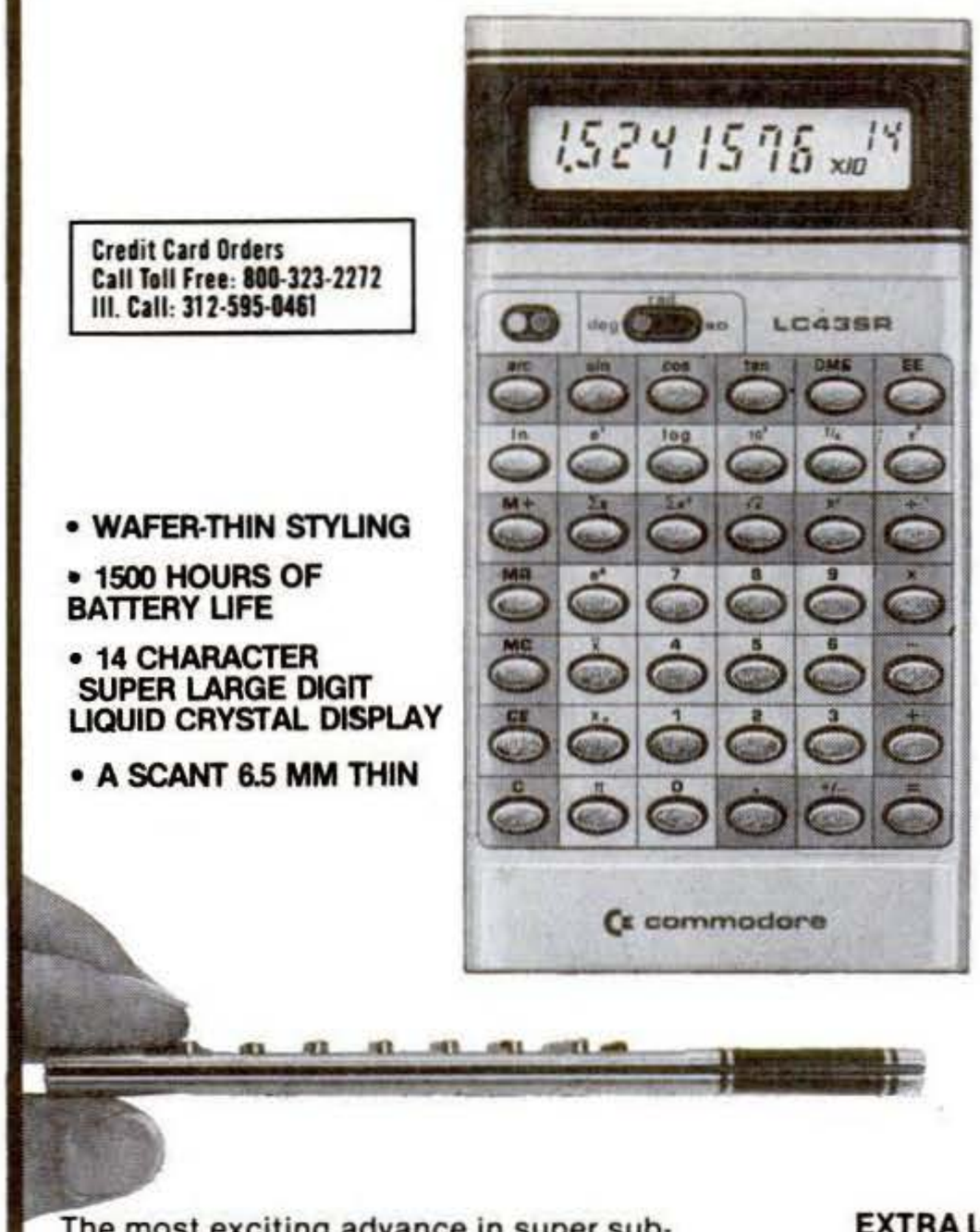

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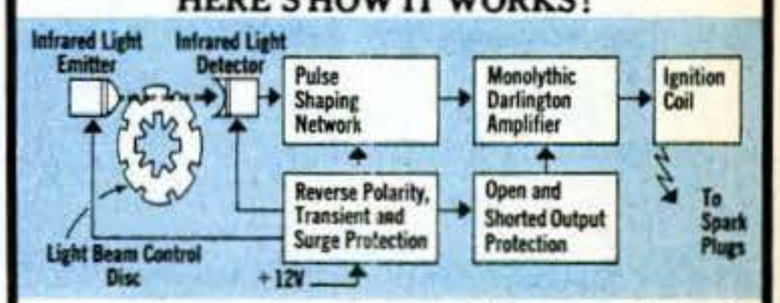

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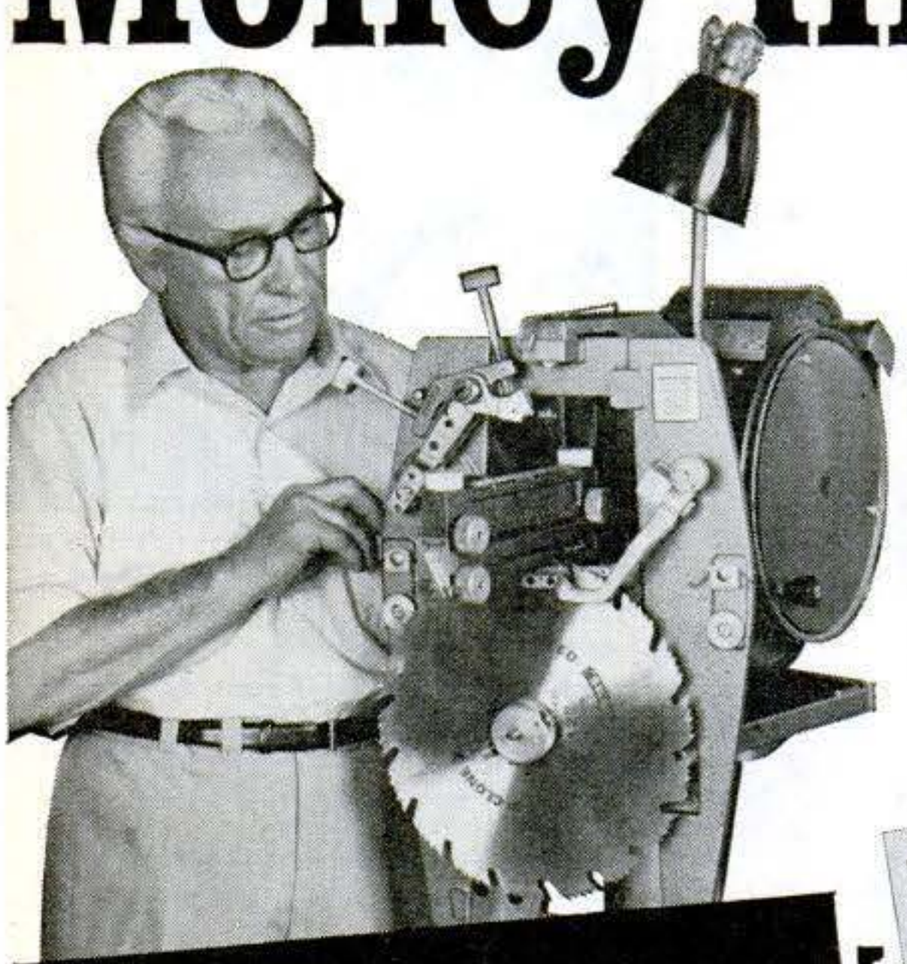

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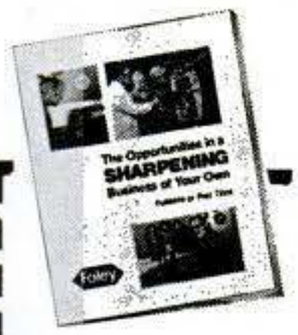

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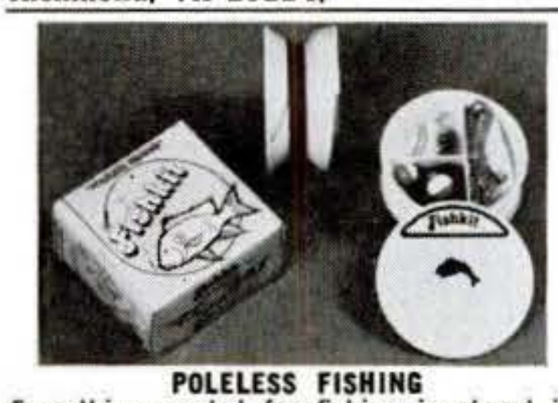

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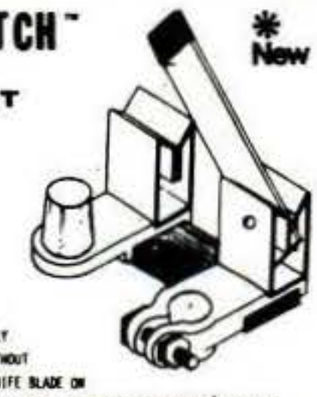

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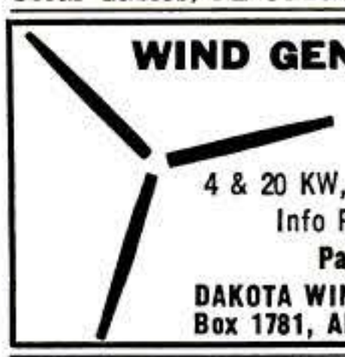

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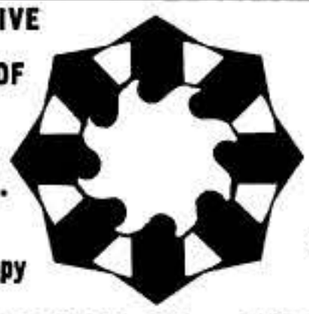

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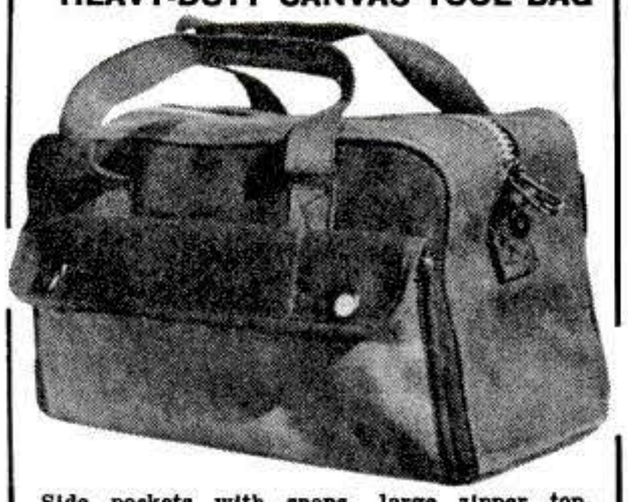

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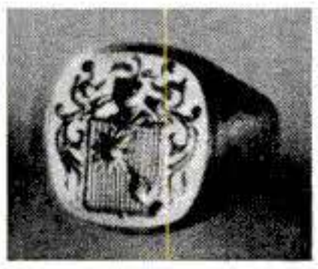

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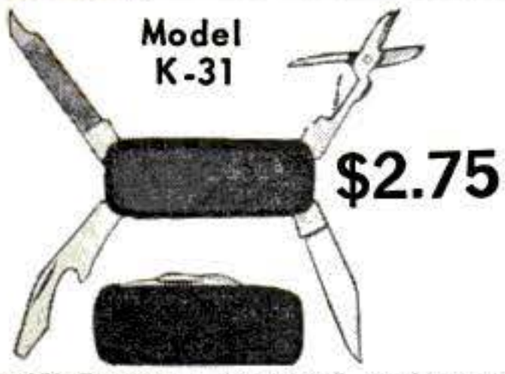

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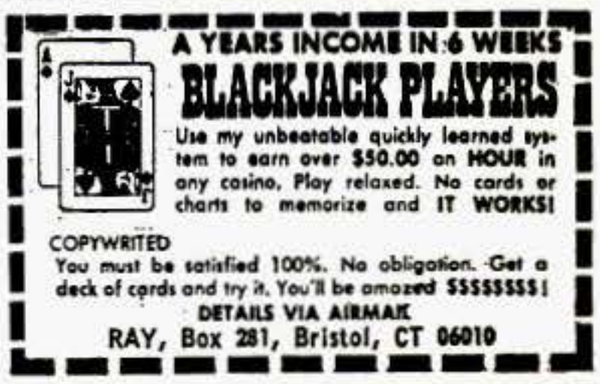

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Detailed 100-page catalog of plastics for the industrialist and the consumer. Property and conversion charts and specifications are included. From AIN Plastics. $1

1116 Burglar Deterrent
Brochure describes system designed to protect home and family. Operates on low voltage, mounts on the exterior of the house. From American Manufacturing Services. Free

1117 When Do I Plant?
Handy, pocket-size garden guide from Ames tells how and when to plant all kinds of vegetables, from A to Z. Also provides a chart on tool selection, pest control, and watering. 25¢

1118 Roofing and Siding Booklet
Thirty-six-page color brochure describes roofing, vinyl siding, shutters, downspouts, and more. All designed to make your home virtually maintenance-free. From Bird & Son, Inc. 50¢

1119 Adherable Energy-Saver
Nun-Sun film reduces glare, fading, and heat—yet allows vision from home or vehicle. Sample and description of do-it-yourself energy-saver from B&R Enterprises. 25¢

1120 How to Choose and Care for Household Cutlery
Handy brochure describes different types of knives and their uses, what to look for in buying good knives, how to sharpen and care for them. From Case Cutlery. 25¢

1121 Learn-to-Fly
The advantages of learning to fly a Cessna aircraft are described in this exciting brochure from the world's largest network of flight-training centers. Free

1122 Great Footwear for the Great Outdoors
Six-page brochure reviews complete line of Dunham outdoor footwear. Includes Duraflex waterproof boots and Continental Tyroleans hiking boots. Free

1123 Fenwick Lunker Gazette
Six issues of the Lunker Gazette news magazine, filled with fishing tips. Published bimonthly. $1

1124 Campground Directory
Booklet describes locations of 34 Holiday Inn Trav-L-Parks with more than 7000 campsites. Information for making free reservations is included. Free

1125 Hyde Mfg. How-To Book
How-To book with 24 pages of drawings shows how to prepare surfaces for painting, decorating, restoring, joint finishing. Plus dozens of other decorating tips. 50¢

1126 Spiral Stairs
Twelve-page brochure has step-by-step photos showing easy assembly of a handsome spiral staircase from a kit. Railings and tread accessories are also included. From the Iron Shop. Free

1127 Marlin Firearms
Thirty-two-page color catalog describes and illustrates Marlin's full line of sporting rifles and shotguns. Free

1128 Creative Paneling Ideas
Masonite's color booklet shows conventional and unusual ways to use wall paneling in every room. Remodeling ideas, do-it-yourself suggestions, and dramatic redecorating tips. 50¢

1129 Facts of Laundry
Maytag booklet discusses laundry sorting and preparation, uses of laundry additives, proper loading of washer, and correct temperature selection. Also includes section on clothes dryer. Free

1130 Sanding Tips
Bulletin shows homeowners and do-it-yourselfers ways to eliminate tedious hand sanding of contoured and irregular surfaces and how to save time with proper sanding techniques. From Merit Abrasive Products. Free

1131 Floor and Wall Bricks
Brickettes with 12 unique blends can create a distinctive fireplace, a new room divider, or an elegant wall. Brochure illustrates easy-to-install fireproof brick from Modern Methods. Free

1132 Vehicle Accessories
Mountain Man catalog describes line of can carriers, tire mounts, boat racks, and other accessories for the four-wheeler. Attachments fit most recreational vehicles, vans, motor homes, and trailers. $2

1133 Radio Control
Informative pamphlet from Proline Electronics describes how radio control systems are used for model aircraft, sailplanes, boats, and cars. Also includes technical catalog of specifications, frequencies, and description of various R/C systems. $2

1134 Do-It-Yourself Plumbing
Instruction booklet for tool-less technique requiring no more than a pocketknife and pliers for simple plumbing. From Qest. Free

1135 Window Channels
Pamphlet describes Quaker take-out channels that make your existing windows removable for cleaning, painting, and replacement of broken glass. Free

1136 RV Parts and Accessories
Fredson Trailer Supply's mail-order catalog contains thousands of items for your outdoor needs. Parts and accessories for recreational vehicles, vans, mobile homes, boats, and campers. From R&L Advertising. $1

1137 Shenandoah Book on Wood Heat
Color catalog with tips on installation, wood selection, heater choice, product features, and useful ideas on solid-fuel heaters. 50¢

1138 *Homeowner's How To Handbook*
Current issue of *Popular Science*'s source of expert advice to homeowners on how to repair, remodel, and maintain their homes and keep their lawns and gardens attractive. $1.50

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Note: *Popular Science*'s **Iowa address is for Product Information only. Subscription inquiries should be directed to the address at the foot of the table-of-contents page.**

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POPULAR SCIENCE NOVEMBER 1977

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Introducing the wagon that has America singing

You guessed it.

After all, you don't find people singing about ordinary wagons. Just extraordinary ones. Which, we modestly propose, is precisely the category the 1978 Plymouth Volaré wagon fits into.

Reason number one is the most obvious. That cavernous space you see below. Where those kids could lug home about 60 bushels of shells, or fish, or something else suitably exotic. (Parental guidance suggested.)

Of course, the nice thing about lugging anything around in a Volaré is that you never lug around a lot of car. Because Volaré is a trim, compact wagon. Maneuverable. Easy to park. And, a pure joy to drive. Thanks to the Isolated Transverse Suspension. An ingenious system designed to keep life's bumpy road as far away from you as possible.

Other comforts also abound in Volaré. Like a gas pressurized liftgate that opens part way on its own. And two optional lockable storage compartments to keep "out-of-sight" valuables out of sight.

Volaré. People have been singing its praises since the day we brought it out. So much so, in fact, that last year, they helped make it the No. 1 selling wagon in America.

And if we're hearing it right (ah, what a great sound) that's exactly where it's going to remain.

Buy or Lease a Volaré at your Chrysler-Plymouth Dealer today.

New 1978 Plymouth Volaré.
The car with the accent on value.

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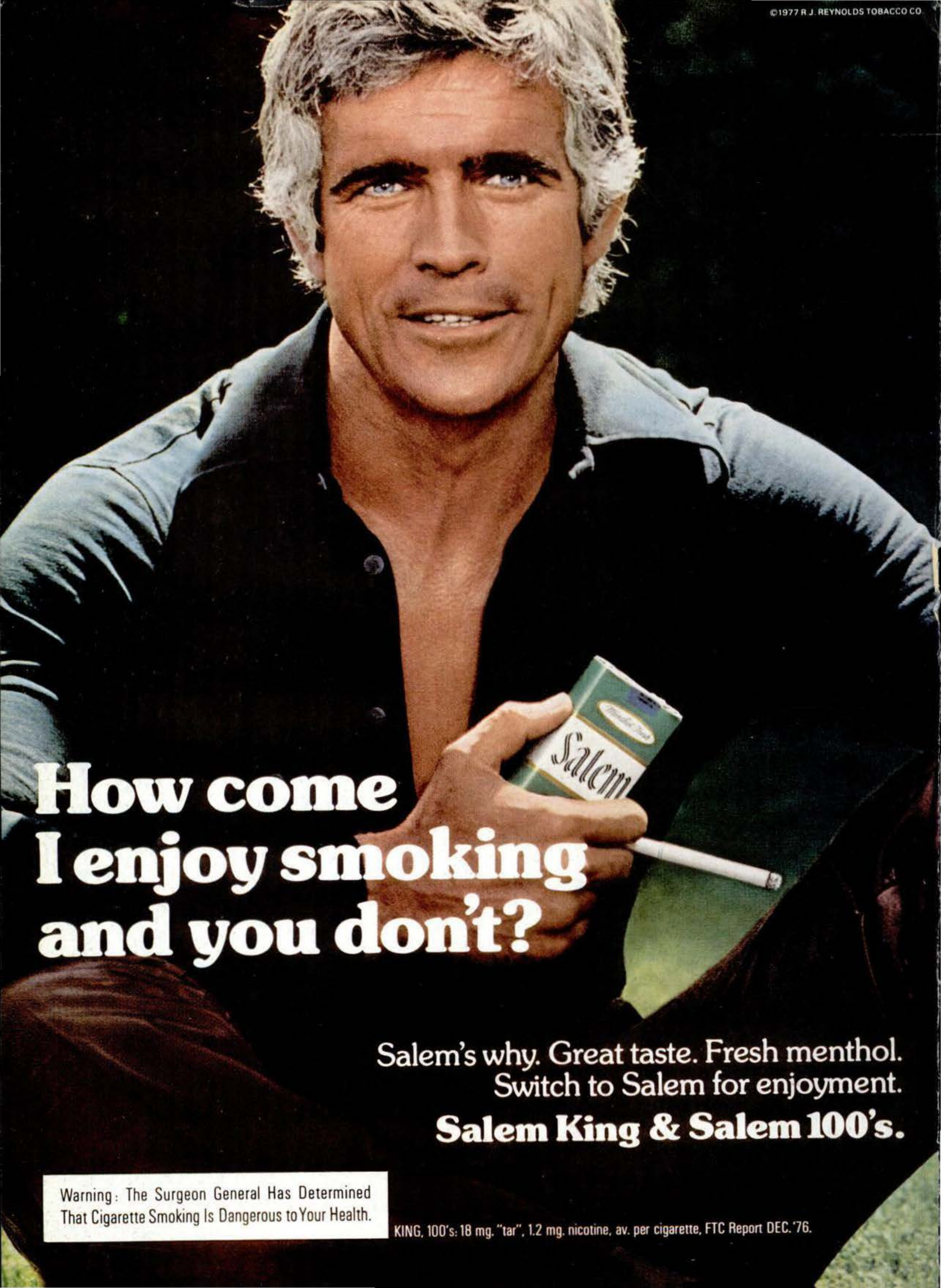

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